SYNTHESIS OF SOME NITROGENOUS COMPOUNDS

ABSTRACT

THESIS SUBMITTED FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

CHEMISTRY

TO

THE ALIGARH MUSLIM UNIVERSITY

ALIGARH

BY

RASHID HUSAIN ZUBERI

DEPARTMENT OF CHEMISTRY

ALIGARH MUSLIM UNIVERSITY

ALIGARH–INDIA

1983

ABSTRACT

A B S T R A C T

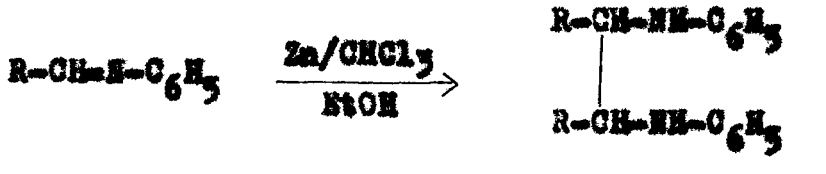
Syntheses of bimolecular reduction products of Schiff's bases and phenylhydrazones are described. Schiff's bases and phenylhydrazones, when refluxed for varying lengths of time with zinc dust in presence of ethanolic chloroform, undergo reductive dimerisation yielding the bimolecular reduction products.

Schiff's Bases

Schiff's bases or imines used in this work were prepared by treating aldehydes, ketones and keto acids with aniline in equimolar proportions in the presence of acetic acid.

Bimolecular Reduction

Reduction of Schiff's bases, using zinc dust and ethanolic chloroform (20:1) as reducing agent, resulted in the formation of bimolecular products in yields noted against each.



(I-XXIV) (XLIII-LXVI)

1. 1,2-Diphenyl-1,2-diaminophenylethane (93.5%)(XLIII)
2. 1,2-Di-(4-dimethylaminophenyl)-1,2-diaminophenylethane (95%)(XLIV)
3. 1,2-Di-(2-methoxyphenyl)-1,2-diaminophenylethane (93.5%) (XLV)
4. 1,2-Di-(3,4-dimethoxyphenyl)-1,2-diaminophenylethane (91.5%)(XLVI)
5. 1,2-Di-(4-nitrophenyl)-1,2-diaminophenylethane (84%)(XLVII)
6. 1,2-Di-(2-hydroxyphenyl)-1,2-diaminophenylethane (85%) (XLVIII)
7. 1,2-Di-(2-nitrophenyl)-1,2-diaminophenylethane (94%) (XLIX)
8. 1,2-Di-(2,4-dihydroxyphenyl)-1,2-diaminophenylethane (88%)(L)
9. 1,2-Di(3,4,5-trimethoxyphenyl)-1,2-diaminophenylethane (74%)(LI)
10. 1,2-Di-(4-hydroxyphenyl)-1,2-diaminophenylethane (86%)(LII)
11. 1,2-Dicrotenal-1,2-diaminophenylethane (85%)(LII)
12. 1,2-Dipropane-1,2-diaminophenylethane (92%)(LIV)
13. 1,2-Dimethyl-1,2-diaminophenylethane (81%)(LV)
14. 1,2-Dicinnamal-1,2-diaminophenylethane (88%)(LVI)
15. 1,2-Dipyridyl-1,2-diaminophenylethane (93.5%)(LVII)
16. 1,2-Difurfural-1,2-diaminophenylethane (83.5%)(LVIII)
17. 1,2-Diethyldiphenyl-1,2-diaminophenylethane (93.5%(LIX)
18. 1,2-Diphenyldimetnyl-1,2-diaminophenylethane (94%)(LX)

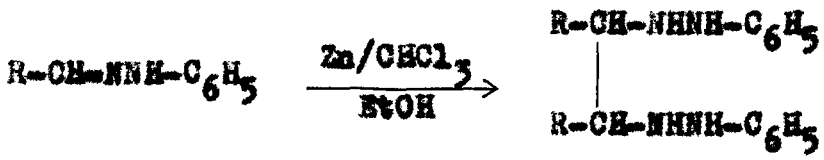
19. 1,2-Dicyclohexane-1,2-diaminophenylethane (92%)(LXI)
20. 1,2-Diethyldimethyl-1,2-diaminophenylethane (86%)(LXII)
21. 1,2-Dimethyl-1,2-diaminophenylethane (85.5%)(LXIII)
22. 1,2-Dimethyl-(1,2-dicarboxyethane)-1,2-diaminophenylethane (85.5%)(LXIV)
23. 1,2-Dicarboxy(1,2-dicarboxyethane)-1,2-diaminophenylethane (82%)(LXV)
24. 1,2-Tetracarboxy-1,2-diaminophenylethane (86.5%)(LXVI)

Phenylhydrazones

The synthesis of phenylhydrazones of carbonyl compounds was carried out by treating carbonyl compounds with phenylhydrazine in presence of glacial acetic acid as catalyst.

Reductive Dimerisation

Phenylhydrazones when subjected to chemical reduction with zinc dust and ethanolic chloroform afforded the dimerised products in excellent yields noted against each.



(XXV-XLII) (LXXVII-LXXXIV)

1. 1,2-Diphenyl-1,2-dihydrazophenylethane (95%)(LXVII)
2. 1,2-Di-(2-nitrophenyl)-1,2-dihydrazophenylethane (85%) (LXVIII)

3. 1,2-Di-(4-dimethylaminophenyl)-1,2-dihydrazophenylethane (98%)(LXIX)
4. 1,2-Di-(2-hydroxyphenyl)-1,2-dihydrazophenylethane (78%)(LXX)
5. 1,2-Di-(4-hydroxyphenyl)-1,2-dihydrazophenylethane (77%)(LXXI)
6. 1,2-Di-(3,4-dimethoxyphenyl)-1,2-dihydrazophenylethane (80%)(LXXII)
7. 1,2-Di-(2-nitrophenyl)-1,2-dihydrazophenylethane (73%) (LXXIII)
8. 1,2-Di-(4-hydroxy-3-methoxyphenyl)-1,2-dihydrazophenyl-ethane (78%)(LXXIV)
9. 1,2-Dicinnamal-1,2-dihydrazophenylethane (85%)(LXXV)
10. 1,2-Di-(4-methoxyphenyl)-1,2-dihydrazophenylethane (72%) (LXXVI)
11. 1,2-Difurfural-1,2-dihydrazophenylethane (63%)(LXXVII)
12. 1,2-Dipyridyl-1,2-dihydrazophenylethane (68%)(LXXVIII)
13. 1,2-Dicarboxymethane-1,2-dihydrazophenylethane (65%)(LXXIX)
14. 1,2-Dicarboxy-(1,2-dicarboxyethane)1,2-dihydrazophenylethane (61%)(LXXX)
15. 1,2-Dimethyl(1,2-dicarboxyethane)-1,2-dihydrazophenylethane (67%)(LXXXI)
16. 1,2-Dicarboxy-1,2-dihydrazophenylethane (65%)(LXXXII)
17. 1,2-Dicarboxyphenyl-1,2-dihydrazophenylethane (62%)(LXXXIII)
18. 1,2-Dimethyl-4,2-dihydrazophenylethane (69%)(LXXXIV)

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Date.....30/12/1983

CERTIFICATE

This is to certify that the work embodied in this thesis is the original work of the candidate and is suitable for submission.

(Dr. Naseem H. Khan)
Reader.

A C K N O W L E D G E M E N T S

I express my deep sense of gratitude to Dr. Naseem Hasan Khan, Reader, who introduced me into the fascinating realm of Scientific investigations in more than one sense of the word. His able guidance, well meant criticism and keen interest gave me the necessary strength and confidence that I needed for the completion of this work.

I also wish to express my heartiest gratitude to Dr. W. Rahman, Professor and Chairman, Department of Chemistry for providing the research facilities.

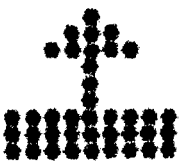
It gives me immense pleasure to place on record my gratefulness to Dr. Amin A. Siddiqui and Dr. Mubarak Husain, whose helpful suggestions and invaluable cooperation came at a time when I felt it most.

I shall be failing in my duties if I do not acknowledge the constant encouragement and helpful suggestions rendered to me by my elder brother Mr. Zamarrud Husain Zuberi, Z.H. College of Engineering & Technology, who has been the resolute source of inspiration to me throughout my educational career. The cooperation of my research colleagues too is thankfully acknowledged.

Last, but not the least, my thanks are also due to the University Grants Commission (New Delhi) for providing me the financial assistance.

(RASHID HUSAIN ZUBERI)

C O N T E N T S



INTRODUCTION

INTRODUCTION

Compounds in which both hydrogen atoms of the amino group of an aromatic or aliphatic amine are replaced by one hydrocarbon residue are termed as Schiff's bases, anils or imines[1]. An aromatic aldehyde such as benzaldehyde and aniline condenses together to form Benzalaniline.

$$C_6H_5CHO + H_2N{-}C_6H_5 \xrightarrow{-H_2O} C_6H_5CH{=}N{-}C_6H_5$$

Benzalaniline

Similar compounds can be obtained from ketones, but condensation does not take place so readily, high temperature in presence of zinc chloride or iodine as a catalyst is required. Schiff's bases can also be obtained by condensing ketodichloride, with amine or with a nitroso compound containing reactive methylene group.

$$RNO + H_3CR' \longrightarrow RN{=}CHR'$$

Schiff's bases are crystalline compounds, which can be distilled without decomposition. They are weak bases

and form hydrochlorides in non-aqueous solvents, their characteristic behaviour is the ease with which they are hydrolysed in non-aqueous acid to aniline and carbonyl compounds.

Properties of Schiff's Bases

Schiff's bases are usually crystalline solids, although in certain sterically hindered cases they are liquids.[23] They have also been noted to exhibit phototropy and thermotropy, e.g. N-Salicylidineanilines.[3a,b]

Ultra violet and visible spectra of imines depend too much on substituents to give any generalised data on them. However, the Raman spectra of a number of imines have been determined. A number of N-alkylidene alkylamines give rise to a Raman line near 1670 cm^{-1}[4]. Cantarel[5] also finds that imines have a Raman line in the same region and compares their characteristic frequency with those of C=C and C=O and finds it to be closer to the later.

$\Delta\nu$	cm^{-1}
C=C	1600 - 1650
C=N	1650 - 1670
C=O	1710 - 1750

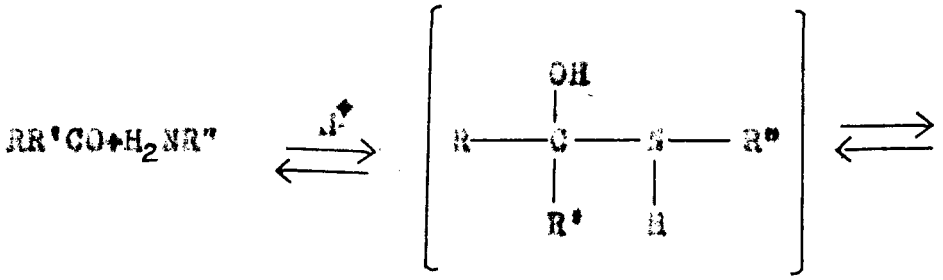
The >C=N- distance for several imines has been deduced from the corresponding Raman frequencies by comparison with the C=O distance for several ketones. The average distance for C=O bond is closer to the accepted value of 1.215 A°, so the imines are considered to be perfectly covalent. Therefore, the N= radius is 0.575A° and the O= radius is 0.665A°.

Preparation of Schiff's Bases or Imines

Schiff bases have been prepared by a variety of methods[1]. A review of few important routes are described as under.

(A) Reaction of Aldehyde or Ketone with Amine

Most common method for the preparation of imines is the reaction of an aldehyde or ketone with primary amine. This reaction was first discovered by Schiff[6] and imines thus obtained are referred to as Schiff's bases.



The reaction is acid catalysed and is generally carried out by refluxing the carbonyl compounds and amine with an azeotroping agent if necessary and seperating the water so formed.

Bigelow and Eatough[7] prepared benzalaniline by the condensation of benzaldehyde with aniline as represented by the following equation:

$$C_6H_5CHO + H_2N{-}C_6H_5 \longrightarrow C_6H_5CH{=}NC_6H_5 + H_2O$$

Primary aliphatic aldehydes in general, give polymeric materials with amines. This is due to the ease with which the imine is initially formed undergoes subsequent aldol condensations. e.g.,

$$X(RCH_2CH{=}NR) \longrightarrow RCH_2CH(=CCH=)_xCCH{=}NR$$

(with R above each C)

Amines containing tertiary alkyl group are reported to give imines with primary aldehydes possibly because steric hinderence makes aldol condensation difficult[8]. It has also been shown that slow addition of a primary aldehyde to an aliphatic amine at 0° followed by potassium hydroxide addition and seperation of the organic material

and distillation yields imines of this type[9]. Mollais[10] has previously obtained imines of this type.

The dimeric form of N-butylidene aniline has been isolated[11,12]. This material can readily deaminate on heating or in the absence of acids to give the α,β-unsaturated imine at room temperature. Other aldehydes are also reported to give similar dimers. Aliphatic amines, aldehydes and ketones do not give dimers.

Secondary aliphatic aldehydes readily form imines with amines[13]. The fact that these aldehydes have only one α-hydrogen makes their imines incapable of splitting to give an α,β-unsaturated imine, which would result in polymerization.

Tertiary aliphatic and aromatic aldehydes react quantitatively with amines to give the corresponding imines even at room temperature. Aromatic aldehydes are so reactive that imines forms even without the removal of water[14]. Sprung has reviewed the reactions of aldehydes with amines[15].

Aliphatic ketones react with amines more slowly than aldehydes to form imines. This necessitates the use of higher temperature and reaction times as in case of

aldehydes. Acidic catalysts are helpful and water removal from the reaction mixture is definitely required. Fairly high yield of Schiff bases can be obtained in this way (80-96%).

The structure of ketone determines yield of aldol condensation product and speed of the reaction. Sterically hindered ketones react more slowly than unhindered ones and Newman's rule of six can be applied to roughly estimate the reactivity of ketones with amines[16]. For example, diisobutyl ketone takes longer period of time to react with aniline than does 2-heptanone[17]. Kuhn's method where silver iodide and aniline hydroiodide in dimethyl formamide gradually reacts with acetone then with sodium hydroxide and potassium cyanide to give a 90% yield of N-isopropylideneaniline[18].

Aromatic ketones react even slower than aliphatic ketones with amines. Here proton and Lewis acid Catalysts as well as high reaction temperature are required. Acetophenone and benzophenone react with aniline at reflux temperatures in presence of aniline hydrochloride or aniline zinc chloride salt to give imines[19]. Ammonia also reacts with these ketones at 180° in 4 hours in presence of

aluminum chloride catalyst[20]. Vapour phase reaction of these ketones with ammonia over thorium oxide at 300-400° is also useful[21]. Hydrogen cyanide catalyses the reaction of acetophenone with aniline. It also adds to the imine to give an α -cyanoamine which can be dehydrocynated at 210° to give imine[22].

Ammonia reacts uniquely with aldehydes and ketons. For example, secondary aldehydes, as isobutyraldehyde, and ammonia gives N,N'-diisobutylidene-1,1-isobutyldiamine[23]. This when distilled slowly eliminates NH_3 and gives N-isobutylideneisobutylamine in 95% yield.

$$(CH_3)_2CHCHO + NH_3 \longrightarrow \left[(CH_3)_2CH\text{-}CH{=}N\right]_2 CHCH(CH_3)_2$$

$$\longrightarrow (CH_3)_2CHCH{=}NCH_2CH(CH_3)_2 + NH_3$$

Similarly tertiary aldehydes, as neopentaldehyde, and ammonia gives N-neopentylideneneopentylamine and t-butyl cyanide in 80% yield.

$$(CH_3)_3CCHO+NH_3 \longrightarrow \left[(CH_3)_3CCH{=}N\right]_2 CHC(CH_3)_3 \longrightarrow$$

$$(CH_3)_3CCH{=}NCH_2C(CH_3)_3 + (CH_3)_3CCN$$

Reaction of Compounds having Carbon-Nitrogen double bond with Organometallics

Busch[24,25] found that the chlorine atom in C-chloro-N-benzylideneanilines could be replaced by alkyl or aryl groups of a Grignard reagent in very good yields to give corresponding imines.

$$PhC(Cl)=NAr + RMgX \longrightarrow PhC(R)=NAr$$

Montagne[26] later found that anilides, which may be regarded as C-hydroxyimines, react with alkyl or aryl Grignards to give corresponding imine in about 40% yield.

$$EtMgBr + PrCONHPh \longrightarrow PrC(Et)=NPh$$

Grammaticakis[27] has also found that oximes of aromatic aldehydes react with Grignard's reagents to give predominantly benzylamine of the Grignard with ketimine as secondary product.

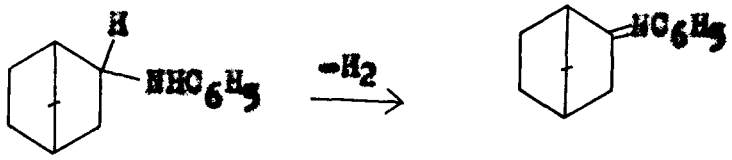
$$ArCH=NOH + RMgX \longrightarrow ArCHNHR + \underset{\displaystyle R}{\underset{|}{ArC}}=NH$$

The slow addition of Grignards to N-chloroimines in ether gives the nitrile in 20% and imine in 50% yield[28].

$$R_2C{=}NCl + R'MgX \longrightarrow RCN + R_2C{=}NR' + RCl + MgX_2$$

Dehydrogenation of Amines

Ritter[29] was the first to dehydrogenate amine to give imines. He found that isobornylaniline is readily dehydrogenated with sulphur at 220° to give an 89% yield of the anil of camphor.



Later it was found that this method is also effective for dehydrogenating benzhydrylamine, N,N'-diisopropylaniline, and N-α-phenylpropylamine. Isobornylaniline is also dehydrogenated with amyl disulfide[30]. Isobornyl acetanilide and sulfur gives the anil of camphor. Numerous side reactions, such as addition of hydrogen sulfide to the imine, reduction of the imine, occurs under these reaction conditions. Selenium is also reported to dehydrogenate amines to imine[31].

Catalytic dehydrogenation of secondary amines over nickel, platinum or chromium catalyst at 180° gives the imines[32,33]

Secondary amines, which are prepared from phenols, hexamethylenetetramine and 2-ethoxyethanol, are readily dehydrogenated to the imine by heating with hexamethylenetetramine in acetic acid[34].

$$(HOC_6H_4CH_2)_2NH \longrightarrow HOC_6H_4CH_2N{=}CHC_6H_4OH$$

Reduction of Carbon-Nitrogen Compounds

Oximes of aliphatic and aromatic ketones can be reduced with hydrogen and nickel under pressure to give ketimines. Acetophenone oximes give the imine in 30% yield[35].

$$R_2C{=}NOH + H_2 \longrightarrow R_2C{=}NH + H_2O$$

Nitriles when hydrogenated over nickel or platinum catalysts can give the imines, but generally the yields are poor due to further reduction to amine and condensations[36].

$$RC{\equiv}N + H_2 \longrightarrow RCH{=}NH + H_2 \longrightarrow RCH_2NH_2$$

$$RCH{=}NH + RCH_2NH_2 \longrightarrow RCH_2NHCH_2R + NH_3$$

Lithium aluminum hydride in tetrahydrofuran has been found to reduce aromatic nitriles to give amines and to give an imine which is formed from the addition of the amine to the nonisolable imine intermediate followed by an elimination of ammonia. This is similar to the above catalytic hydrogenation of nitriles.[37]

$$PhCN \xrightarrow{LiAlH_4} PhCH_2NH_2(50\%) + PhCH_2N{=}CHPh(30\%) + NH_3$$

Nitriles can also be reduced to imines with stannous chloride in ethyl acetate containing hydrogen chloride.[38] Imines are isolated as stannic chloride salt.

α-Nitrostyrenes can be reduced with lithium aluminium hydride below 0° then hydrolysed with 20% aqueous potassium sodium tartarate to give the imine.[39]

Reaction of Nitroso Compounds with Active Hydrogen Compounds

Early workers reported the reaction of active hydrogen compounds with nitroso compounds to give imines.

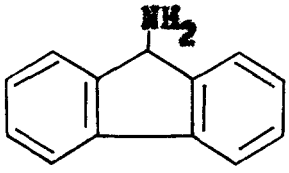
Later workers however, showed that nitrones were the reaction products rather than the expected imines. More recently it has been found that certain active hydrogen compounds do give imines rather than nitrones so that both materials are formed.[40-43]

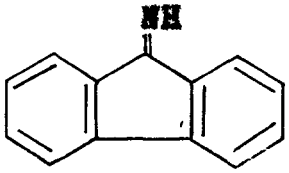
Reaction of Metal Amides

An alkali metal or calcium salt of primary amines reacts with aromatic ketones to give imines.[44]

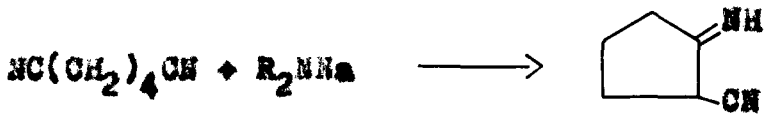
$$(C_6H_5)_2C{=}O + C_6H_5NHNa \longrightarrow (C_6H_5)_2C{=}NC_6H_5$$

Hauser[45] allowed 9-aminofluorine and potassium amide to react in ammonia to give the imine in 50% yield. In the same way, benshydrylamine gives a low yield; however, when benshydryl chloride is added, the yield is raised to 78%.

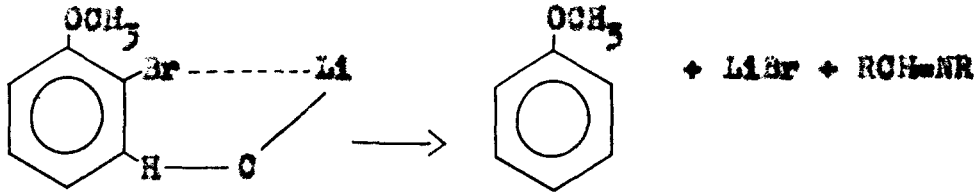




The alkali, calcium, magnesium, or aluminium metal amide of a secondary amine in ether reacts with dinitriles, as adiponitrile, to give the cyclic α-cyanoimine.[46]

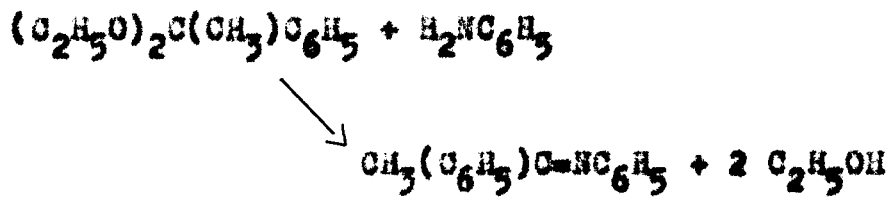


Hoshor[47] has shown that Benkeser's[48] hypothesis that 2-bromoanisole reacts with the lithium amide of a secondary amine containing an α-hydrogen to give an imine is correct. He finds that N-2,2-dimethylpropyl-idene-2'2'-dimethylpropylamine, a very stable imine is formed when lithium diisobutylamide reacts with 2-bromoanisole. The following cyclic mechanism is proposed. Less stable imines can not be prepared in this manner.



Miscellaneous Methods

Diethyl ketals when refluxed with alkyl and aryl amine give imines.[49,50] Excellent yields are obtained with aromatic amines while aliphatic amines give poor yields.



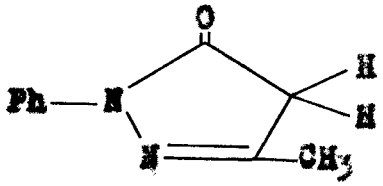
Tertiary alkyl or aryl nitriles react with sodium in petroleum ether to give the di-t-alkyl or aryl ketimines in good yield.[51]

$$R_3CCN + Na \longrightarrow (R_3C)_2C{=}NNa \xrightarrow{H^+} (R_3C)_2C{=}NH$$

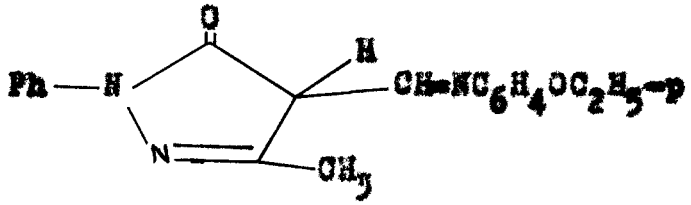
Imines react with other amines to give the exchange products. In cases where the added amine is higher boiling than the amine of the imine, a good yield of the exchanged product can be obtained by distilling off the low-boiling amine.[52,53]

$$RNH_2 + R'N{=}C\begin{matrix}\diagup\\\diagdown\end{matrix} \rightleftharpoons R'NH_2 + RN{=}C\begin{matrix}\diagup\\\diagdown\end{matrix}$$

Barbituric acid reacts with di-phenethylformamidine in refluxing dioxane to give the imine in good yield.[54]



$+ (p\text{-}C_2H_5OC_6H_4)_2CO$



Nitrones react with KCN to give C-cyano imines.[55]

$$C_6H_5CH{=}N(O)C_6H_5 + KCN \longrightarrow C_6H_5\underset{\displaystyle CN}{\underset{|}{C}}{=}NC_6H_5$$

Ethyl N-phenyl forminidate, when heated with polycyclic phenols, give imine; thus, β-naphthol at 150° gives 2-hydroxy-1-naphthylideneaniline. Ethyl N-phenyl-forminidate can be formed in situ from ethyl orthoformate, aniline and diphenylformamidine.[56]

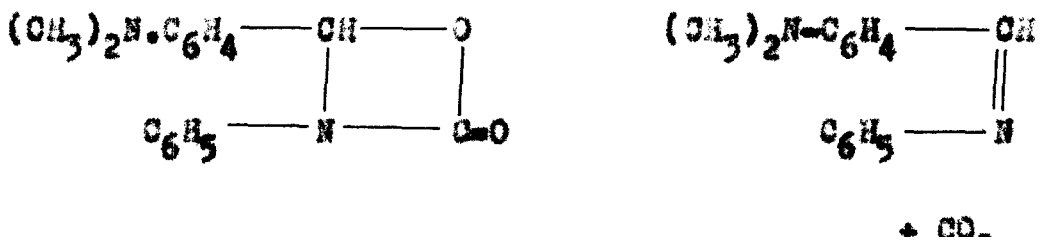
Phenylisocyanates and p-dimethylaminobenzaldehyde at 190° form the imine in nearly quantitative yield.

$$C_6H_5NCO + p\text{-}(CH_3)_2NC_6H_4CHO \longrightarrow$$

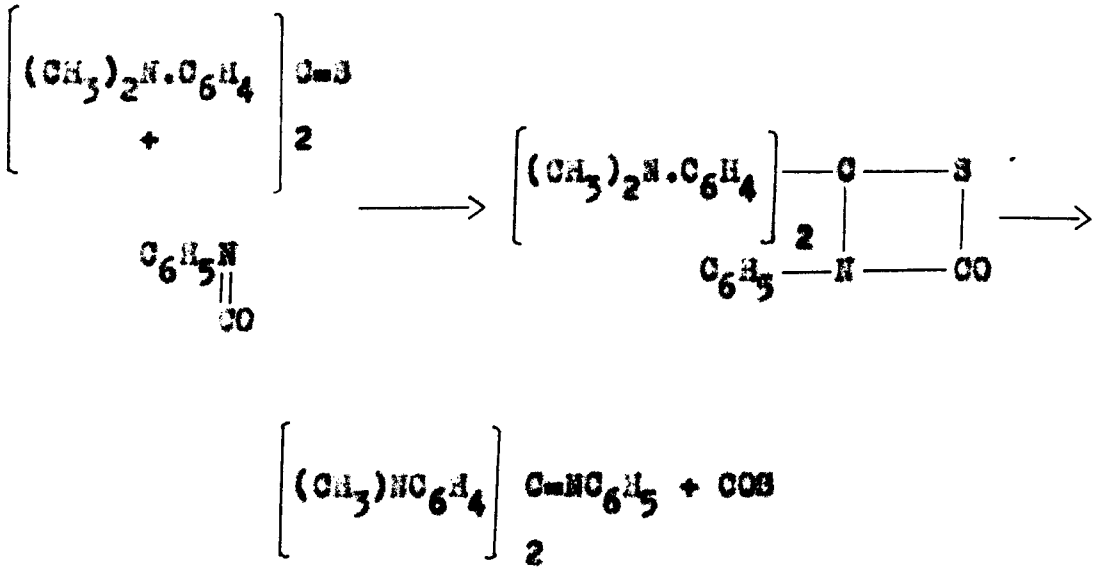
$$p\text{-}(CH_3)_2NC_6H_4CH{=}NC_6H_5 + CO_2$$

Similarly phenyl-isocyanates and bis-(p-dimethyl-aminophenyl) thio ketone give the same product with COS liberation.[57]

$$(CH_3)_2NC_6H_4CHO + C_6H_5N{=}C{=}O \longrightarrow$$



+ CO.



N-Benzylidene and N-cinnamylidenechloramines are thermally decomposed at 120° to 210° to give nitriles in 90% yield. The imines are formed as a by product in about 5% yield.[58] Olefins, tertiary alcohols or halides react with hydrazoic acid in sulfuric acid yielding imines.[59]

Benshydrol under the same conditions gives N-benzylideneaniline in 90% yield.[60] Imines are formed as a by product in the Hofmann rearrangement of benshydryl-acetamide.[61]

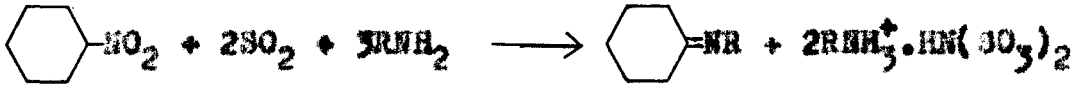
Oximes or the benzoyl derivatives of α-amino ketones (containing two α-hydrogens) solvolyse, when in the anti form, to give the imine and nitrile.[62]

$$(CH_3)_2NCH_2C(C_6H_5)=NOC(O)C_6H_5 \longrightarrow (CH_3)_2N=CH_2 + C_6H_5CN + C_6H_5COOH$$

Hydroperoxides and peroxides have recently been shown to oxidise primary and secondary amines to imines. Thus t-butylhydroperoxide and 4-methyl-2-pentylamine gives 2-(4-methylpentylidene)-4-methyl-2-pentylamine in 66% yield.[63]

$$RNHCHR'R'' + R'''OOH \longrightarrow RN=CR'R'' + R'''OH + H_2O$$

Secondary nitroalkanes react with primary amines in petroleum ether at 60° to give primary bis-(cyclohexylamine)imidodisulphate alongwith some imine.[64]



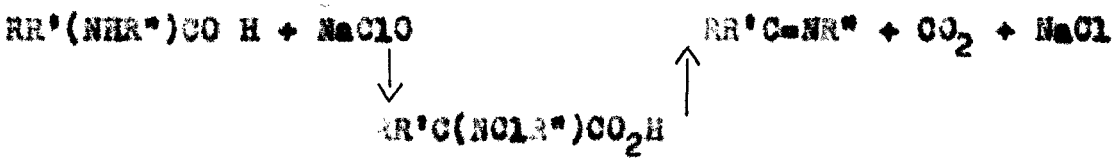
Urea and cyclohexanone in refluxing triethylamine gives N-cyclohexylidene-2-carbamylcyclohex-1-enylamine in 28% yield.[65]

Alkylidenetriphenylphosphoranes react with nitrosobenzene to give anil.[66]

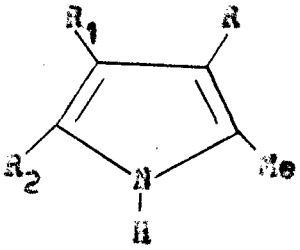
$$RR'C{=}P(C_6H_5)_3 + ONC_6H_5 \longrightarrow RR'C{=}NC_6H_5 + OP(C_6H_5)_3$$

Ketones, as well as amines as previously noted can react with ketimines to exchange the higher for the lower boiling ketone.[67] The reaction is acid catalysed. This reaction is especially suitable for preparing α,β-unsaturated imines. Since the unsaturated aldehydes like crotonaldehyde or α-methylacrolein, gives 1,3-diaminopropanes by 1,4-addition with amines instead of the desired imines.[68]

α-Amino acids react with sodium hypochlorite to give the chloramine intermediate which decomposes with the elimination of CO_2 and sodium chloride to give the imine.[69]



The treatment of pyrrolecarboxaldehyde with p-amino benzoic acid and its ester yielded, azomethines[69a] of substituted pyrrole aldehydes.



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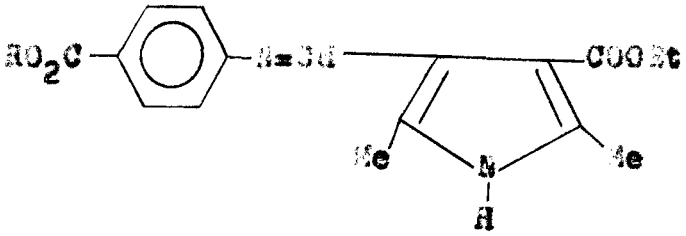

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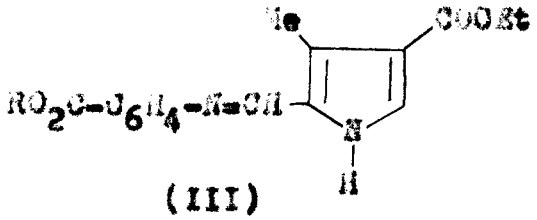

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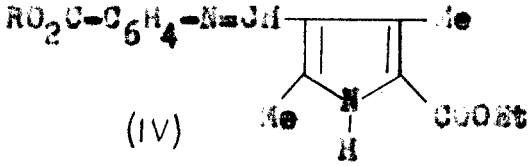
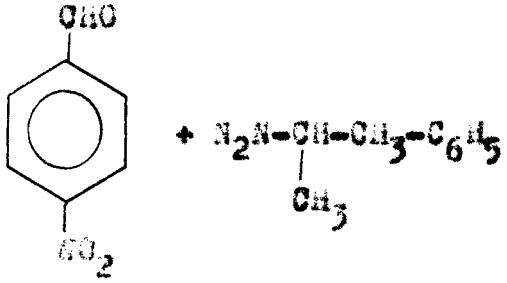
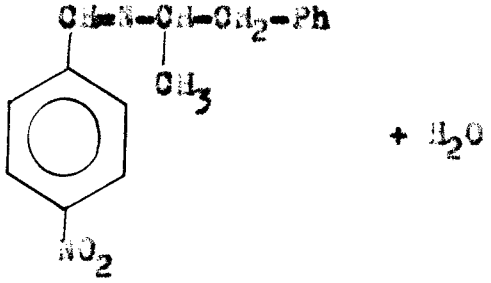


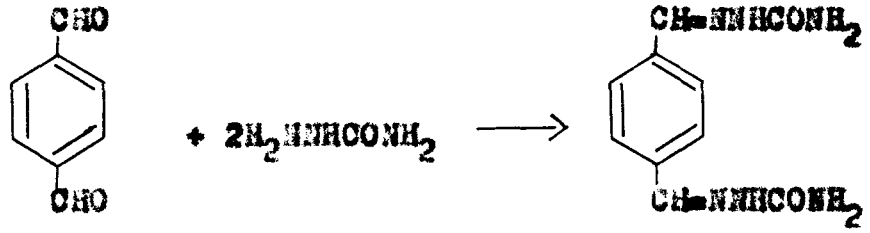
(IV)

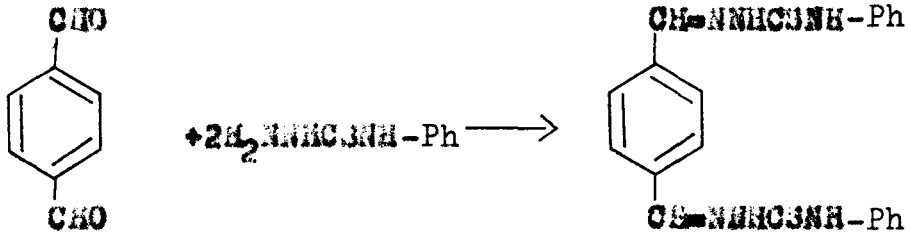
Datlira and Rabas[70] prepared p-O_2N-C_6H_4CH=NCHMeCH$_2$Ph in 90% yield by refluxing 0.1 mole of $H_2NCH(Me)CH_2Ph$ with p-$O_2NC_6H_4CHO$ (0.1 mole) in 20 ml absolute alcohol and 3 drops of acetic acid for 3 hours.



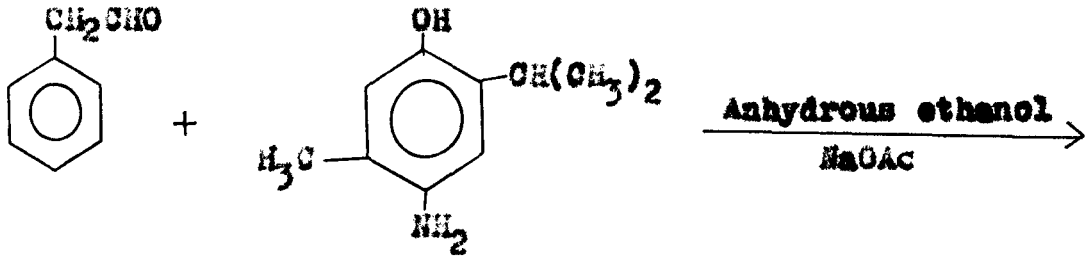


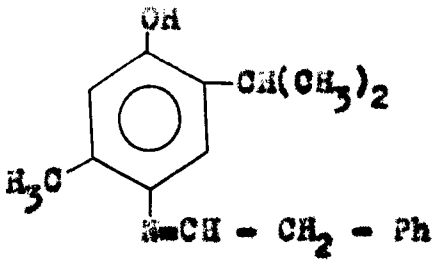
Dey et al.[71] prepared Schiff's bases by the condensation of terephthalaldehyde with semicarbazide or 4-phenylthiosemicarbazide.



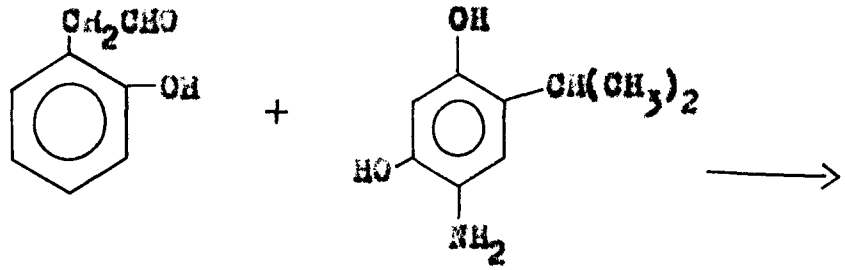


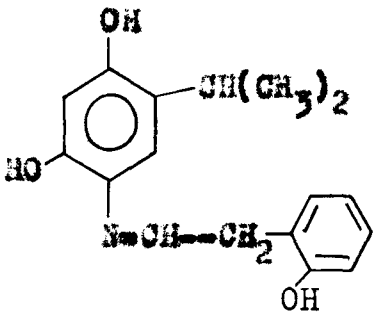
Jenkin et al.[72] prepared six Schiff's bases from p-aminothymol(2-isopropyl-4-amino-5-methylphenol) by condensing with certain aromatic aldehydes to produce safer antipyretic and antianalgesic compounds.





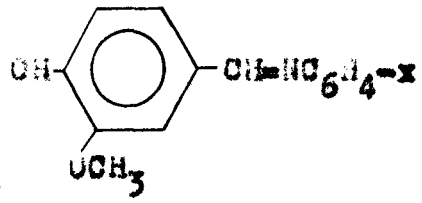
(Benzylidene-4-aminothymol)



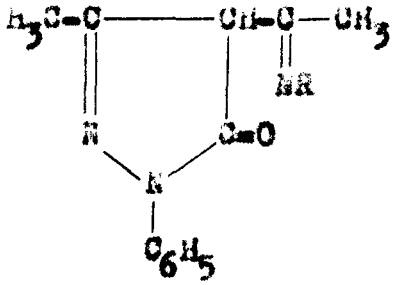


(2-hydroxybenzylidene-4-amino thymol)

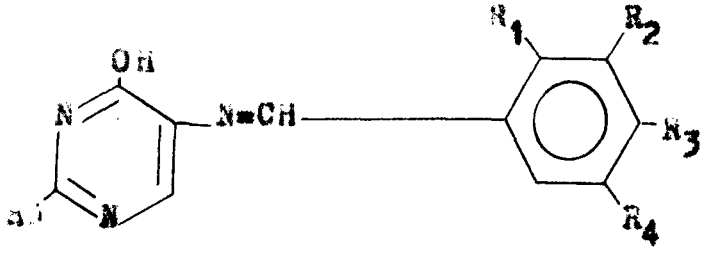
Singh et al.[73] have synthesised nine new Schiff's bases of vanilline in quantitative yields by condensing vanilline with different aromatic amines. Sodium borohydride reduction of these anils to secondary aryl-amines indicated that ortho substitution in the aniline moiety by a CH_3 or an OH group imposed sterric restriction to reduction.



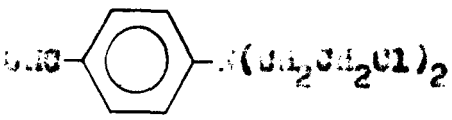
Rao and Mitra[74] prepared Schiff bases by the condensation of aniline with substituted benzaldehydes. Pyrimidine Schiff bases were synthesized as possible anticancer agents. 1-Phenyl-3-methyl-2-pyrazoline-5-one on fusion with acetamide followed by alkaline hydrolysis and subsequent acidification yields 1-phenyl-3-methyl-4-acetyl-2-pyrazoline-5-one.



Synthesis of pyrimidine Schiff bases[75] as potential anticancer agents by the condensation of 5-amino uracil with different disubstituted aromatic aldehyde has been carried out.



Popp[76-78] has prepared a variety of anil derivatives (such as II) from benzaldehyde nitrogen mustard. p- ,N-bis(2-chloroethyl) amino benzaldehyde (I) in order to study the scope of the reaction and to obtain some potentially useful derivatives.



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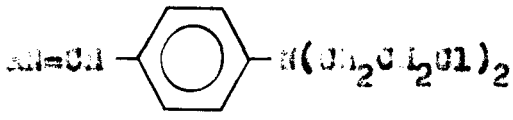
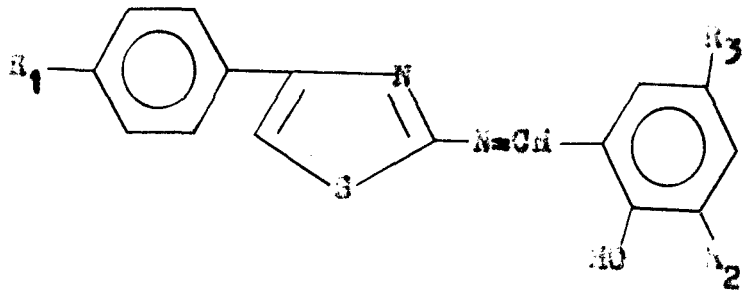


(II)

Thiazole and ebenzothiazole are well known biologically active compounds.[79-84] 4-Aryl-2-aminothiazoles and 2-amino-benzothiazoles undergo condensation with salicylaldehyde in presence of piperidine to give Schiff's base II and III, respectively. A similar reaction of 4-aryl-2-amino-thiazole methiodides give the schiff base,



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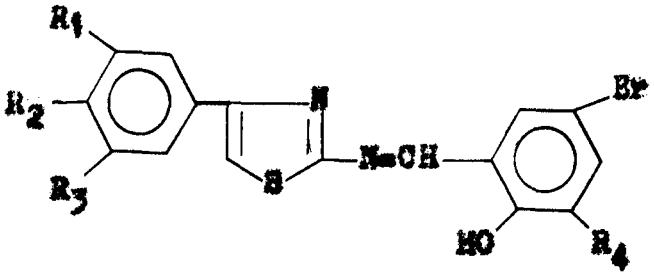
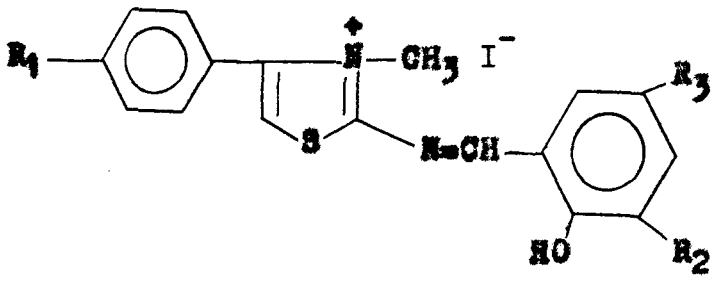


(III)

4-aryl-2-(2'-hydroxyaryliminomethyl) thiazole methiodide (IV). Several Schiff bases have been condensed with cyclohexanone and thioglycolic acid[85] to furnish 4-aryl-2-(2'-hydroxy-α-substituted benzylamino) thiazole(V) and 2(2'-hydroxyphenyl or naphthyl)-3-(4"-arylthiazole-2"-yl)-4-thiazolidone (VI) respectively.



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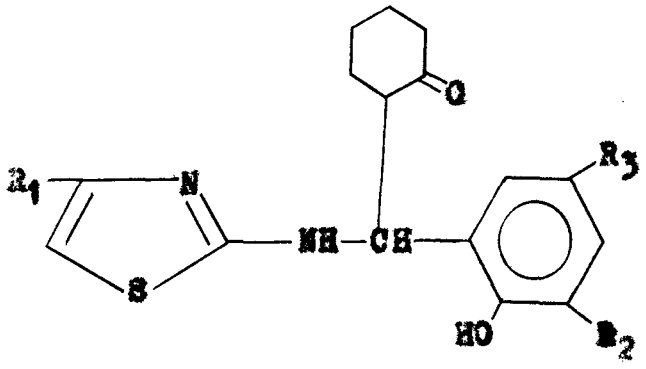

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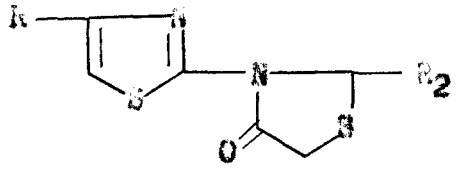
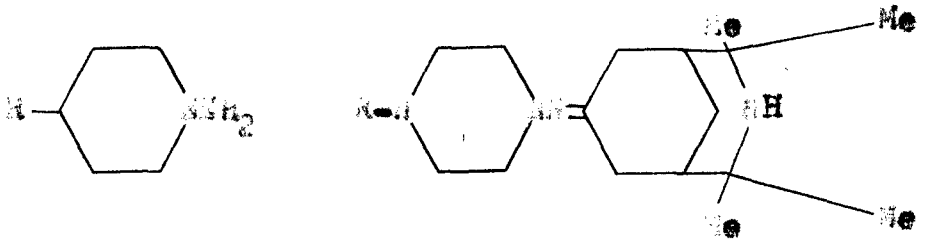


(VI)

Further, the biological activities of certain Schiff's bases prepared as benzylidene amines (PhCH=NR) were synthesized by the condensation of primary amines with benzaldehyde, these Schiff bases have shown good fungistatic activity.[86]

Zikolova et al.[87] have synthesized new Schiff bases of N'-substituted-N⁴-aminopiperazines with triacetonamine, their pharmacological studies showed that it stimulates the central and peripheral nervous system.

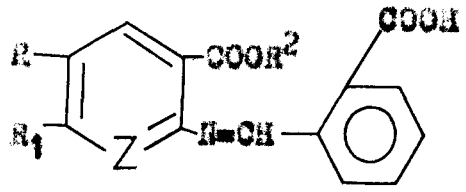


II

A number of azomethines of aliphatic aldehydes (RCH=NR') were synthesized by the azomethines of aliphatic aldehydes with primary aliphatic and aromatic amines and

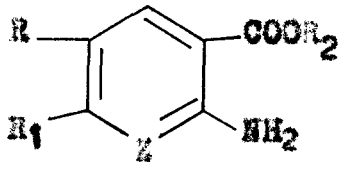
the bacteriostatic and fungicidal activities of these azomethines resembled those of the corresponding aldehydes, but they were often found as stronger bactericides.

Schiff bases[89] as anti inflamatory, anti rheumatic, antiallergic and antihemolytic compounds were prepared by the condensation of benzoic acid derivatives (I) with II at room remperature.



(Z=CH)

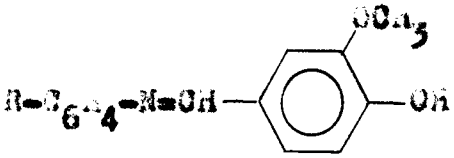
(III)

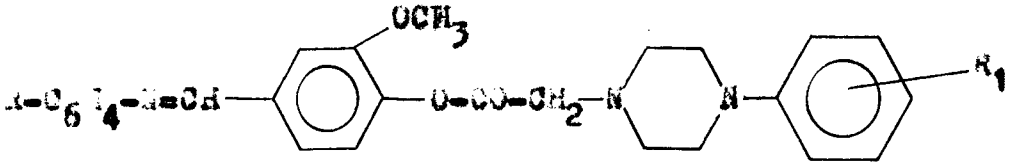


(II)

Tewari et al.[90] synthesized twenty new anilino-α3-methoxy-4-(4-aryl-1-piperazinoacetoxy)benzylidenes, a ten anilino-(3-methoxy-4-(-3-mercapto-4-aryl-1,2,4-(H) trisol-5-yl) methylenoxybenzylidenes. Seven of these compounds were screened for anti convulsant activities. Monoamine oxidase inhibitors have been known to posses pronounced anticonvulsant activity.[91] Some benzylidene derivatives have shown psychotropic properties;[92] and

inhibited in vitro MAO activity.[93] Several piperazine derivatives have been reported as anti convulsants.[94-99]





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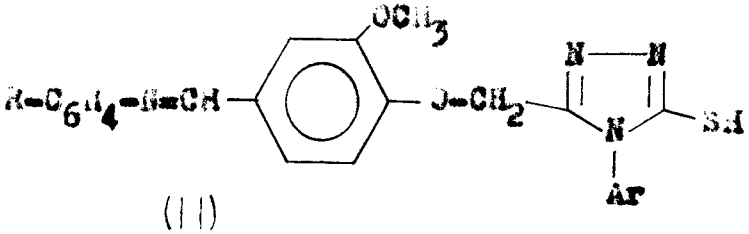


(II)

Furthermore, 1-phenyl-1,2,4-(H)-triazole[100] and mercapto triazole[101] are also found to exhibit anticonvulsant property.[102]

Reaction of Schiff's Bases

It can be recalled that all stages in the preparation of imines from carbonyl compounds and amines are reversible.

Neddelin and Manilof[103] have reported that anils are readily decomposed by aqueous mineral acids, but they

are stable towards aqueous base. Alumina and thoria have also found to be effective catalyst for the hydrolysis of amines.[104]

Catalytic hydrogenations of imines are for the most part avoided when the corresponding amines are desired. In practice a direct reductive alkylation[105] of the carbonyl compound and amine give a higher yield of product in a more convenient way.

$$RR'C{=}O + H_2NR'' + H_2 \longrightarrow RR'CHNHR'' + H_2O$$

N-Benzylideneaniline has also been reduced with cobalt carbonyl, carbon monoxide at 60 atm., hydrogen at 180 atm. and 135°.[106]

There are many chemical reagents which reduce imines. Refluxing sodium in alcohol[107,108] reduced imines. Sodium amalgam is also effective. Zinc and acetic acid is reported to be an effective reducing system as sodium hydrosulfite in basic solution.[109] Magnesium in methanol also reduces imines.[110] Lithium aluminum hydride[111-113] is an effective reducing agent. Sodium borohydride[114] in methanol at 0° also works. The imine group can be selectively reduced in the presence of other groups such as

nitro, chloro, methoxy, and hydroxyl with sodium borohydride.[115,116]

Addition of Primary Amines

Just as water adds to the imines so should primary and secondary amines. The intermediate 1,1-diamino-alkane(II) is not stable and in the case of secondary amines no reaction occurs because deamination of the intermediate, (II) can only give the starting material. In the case of primary amines, the intermediate (II) has

$$\rangle C{=}NH + R'R''NH \longrightarrow \rangle C(NR'R'')NHR$$

(II)

two possible means of deamination and consequently an exchange reaction can occur.

$$\rangle C{=}NH + H_2NR' \longrightarrow \rangle C(NHR')NHR \rightleftharpoons$$

$$\rangle C{=}NR' + H_2N{-}R$$

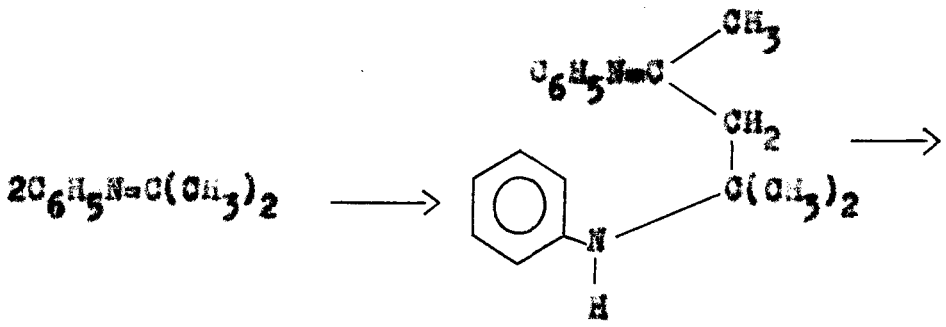
This exchange reaction was first used by Reddelien[117] to obtain imines. Generally the added amine has higher boiling point than the liberated amine. The desired reaction is favoured by removal of lower boiling amine.

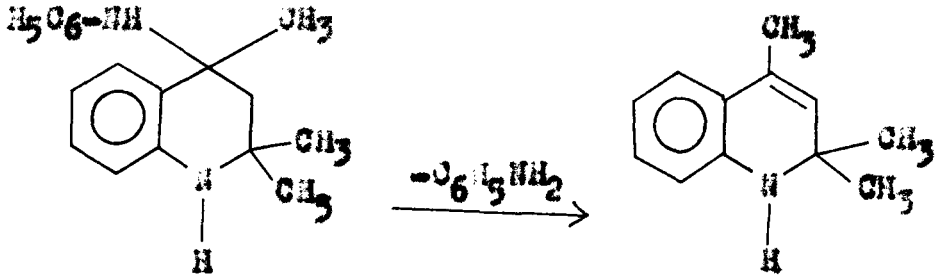
Addition of Active Hydrogen

Numerous compounds containing an active hydrogen add to the imines in the following manner.

$$RR'C{=}NR'' + R'''H \longrightarrow RR'R'''CNHR''$$

Imines derived from aliphatic ketones and aldehydes which contain an α-hydrogen undergo aldol condensations. For example, N-2-propylideneaniline reacts with itself in presence of HCl at about 100° to give 2,2,4-trimethyl-hydroquinoline. This involves an aldol condensation, cyclisation and deamination.[118-120]



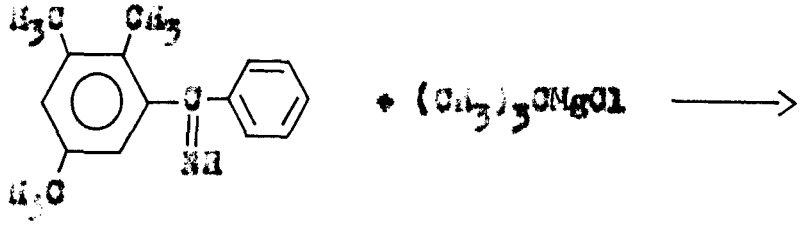


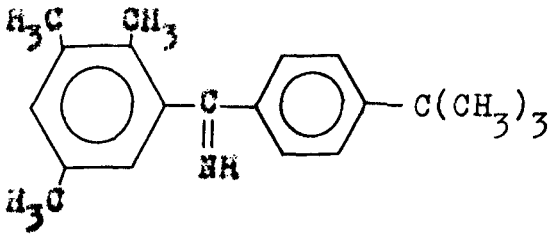
Similarly N-4-butylidene-4-butylamine when refluxed at 150° for 3 hr. gives a 65% yield of N-2-ethylhexen-2-ylidene-n-butylamine.[121]

N-Butylidene aniline on standing at room temperature for 24 hr. gives 70% yield of N-2-ethylhexen-2-ylideneaniline.[122]

Addition of Organometallics

Steric inhibition of the addition of Grignard reagent to certain imines has been reported.[123] N-Benzylidene-t-butylamine does not react with methyl magnesium iodide, while allylmagnesium bromide adds in the usual manner. Apparently steric effects are also responsible for the anomalous reaction of t-butylmagnesium chloride with durylphenylketimine to give duryl-p-(t-butyl)phenyl ketimine.[124]





Addition Reaction of Miscellaneous Compounds

Dialkylphosphites and thiophosphites add to N-benzylideneaniline at room temperature under the catalytic effect of sodium ethoxide to give α-anilinobenzylphosphoric acid dialkyl ethers.[125,126] These materials add to the imine.[127,128]

$$(RO)_2POH + C_6H_5N{=}CHC_6H_5 \longrightarrow (RO)_2P(O)CH(C_6H_5)NHC_6H_5$$

Hypophosphorous acid add to N-benzylideneamine in refluxing ethanol to give aminophosphonic acids. When the amines are aliphatic, 80-90% yields are obtained, while yields in case of aromatic amines are reported to be 30-50%.[129,130]

$$RN{=}CHR' + H_3PO_2 \longrightarrow RNHCHR'PO_2H_2$$

Mercaptans add to N-benzylideneaniline at room temperature in benzene solution. Substituents do not effect

the addition of the mercaptans.[131,132]

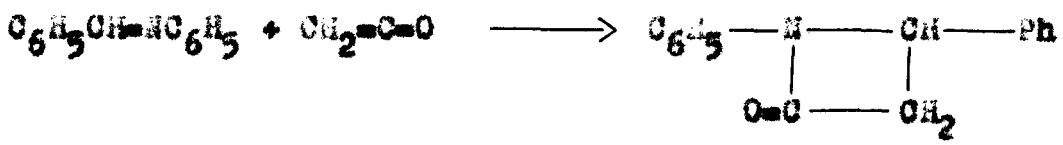
$$C_6H_5CH{=}N{-}C_6H_5 + RSH \longrightarrow C_6H_5{-}\underset{\displaystyle SR}{\underset{|}{CH}}{-}NH{-}C_6H_5$$

Gilman[133] reports that mercaptans reduce imines, but Stacy shows this, to be due to Gilman's more vigorous reaction conditions of refluxing xylene and a 3 fold excess of mercaptan.

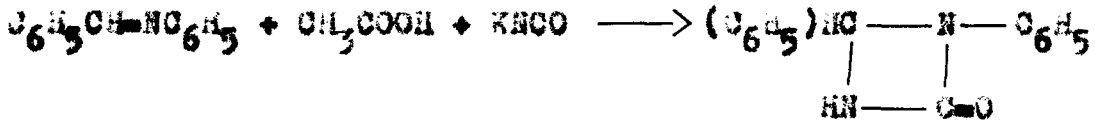
When the mercaptan is mercaptoacetic acid, reaction with N-benzylideneaniline gives the cyclic adduct a diphenylthiazolidone.[134] Both aromatic and aliphatic thiol add across the azomethine linkage.

$$C_6H_5CH{=}N{-}C_6H_5 + HSCH_2COOH \longrightarrow \underset{\displaystyle H_2C}{\overset{\displaystyle O{=}C}{\underset{\displaystyle S}{\overset{|}{\underset{|}{}}}}}\!\!\!

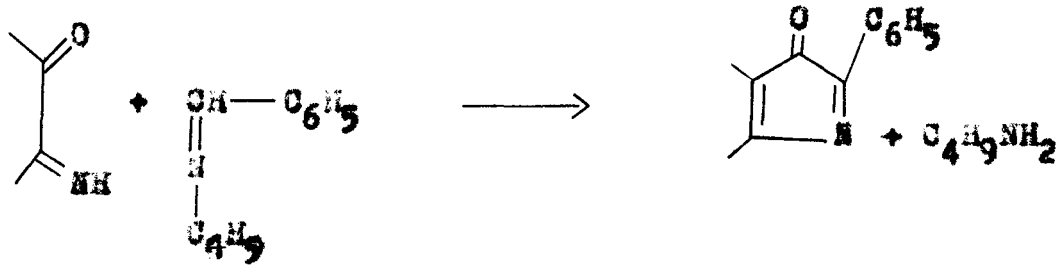
N-benzylideneaniline react with ketenes to give lactams at 180°-200°. Certain ketenes as dicarbethoxy ketene, do not react.[136]



N-benzylideneanilines in acetic acid reacts with potassium isocynate at°C to give 1,4-diphenyluretidone.[137]

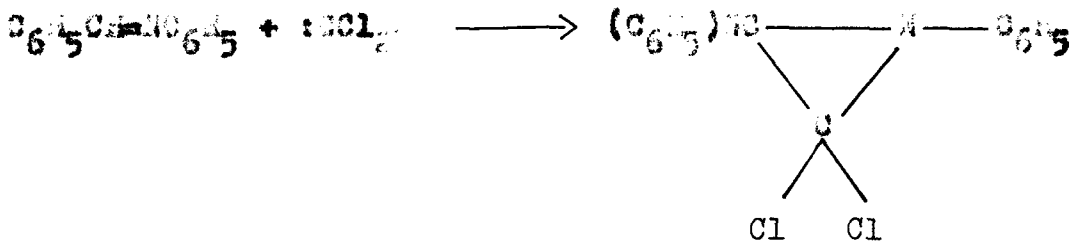


Retenequinonimine reacts with N-benzylidene butylamine on elimination of butylamine to give 2-phenyl-retenoxazole.[138]

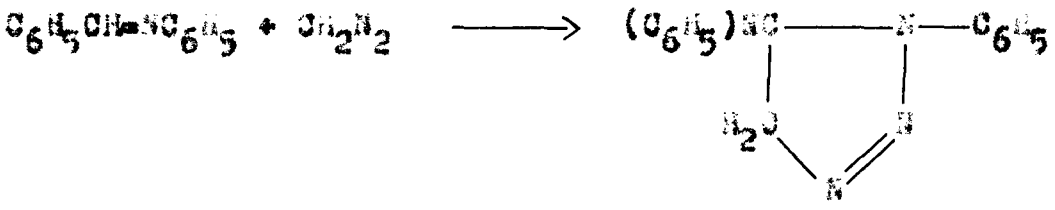


Chloramines add to the imines in ether solution to give diaziridines.[139]

Sodium bisulphite has long been known to add to imines,[140] as has KCN.[141] The carbene obtained from sodium methoxide and hexachloroacetone undergoes the same reaction.[142]

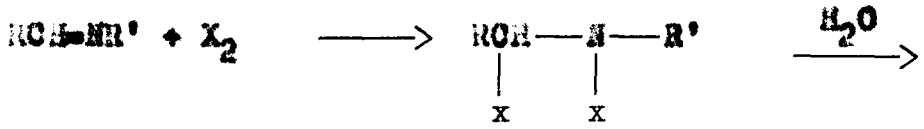


Mustafa[143] was the first to notice that diazomethane reacts with imines to give addition products, to which he assigned a 1,2,4-triazoline structure. This addition product was later found to be a 1,2,3-triazoline.[144]



<u>with halogens</u>[145]

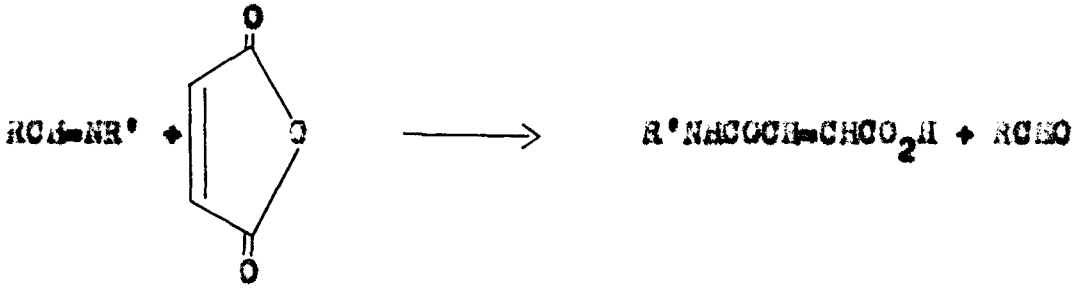
Dihalogen addition compounds may be prepared by the addition of halogens to Schiff base in a dry and inert solvent. The dihalides are susceptible to hydrolysis.



$$RCH{=}NR' + X_2 \longrightarrow RCH(X)-N(X)-R' \xrightarrow{H_2O} RCHO + R'NHX + HX$$

<u>With Anhydrides</u>[146]

The reaction of Schiff bases derived from aniline with maleic anhydride yields maleanilic acids. The reaction is known to be reversible.[147,148]

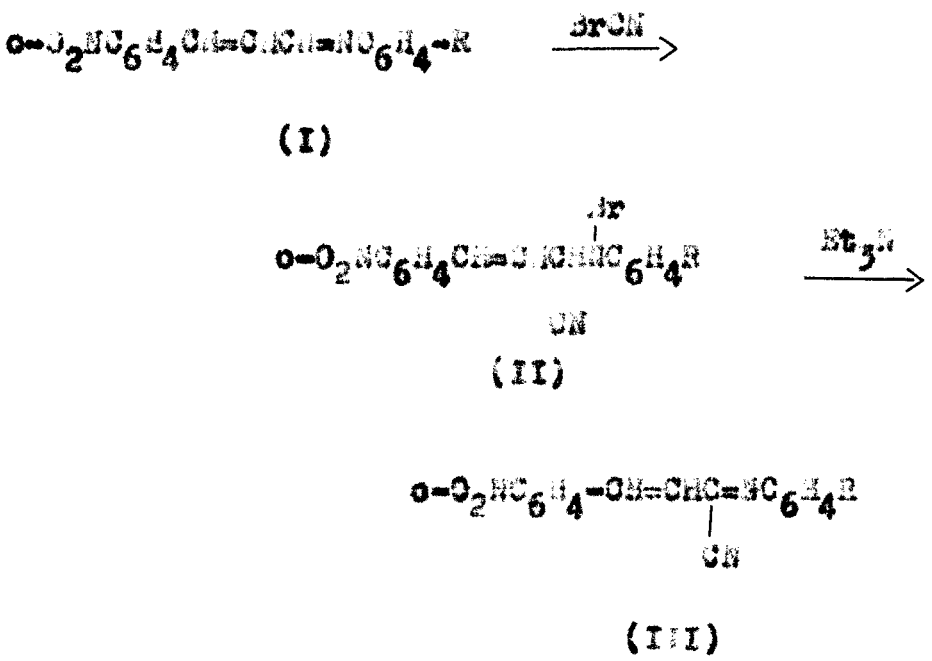


$$RCH{=}NR' + \text{(maleic anhydride)} \longrightarrow R'NHCOCH{=}CHCO_2H + RCHO$$

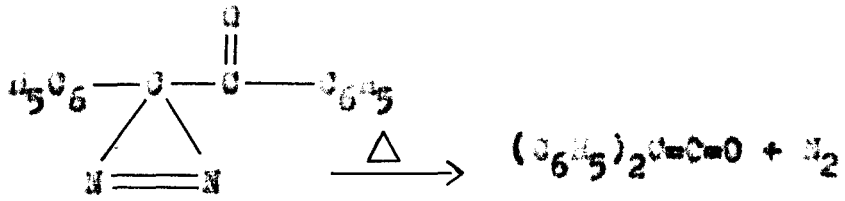
Some other reagents reported to undergo reactions with Schiff's bases are alkyl halides,[149] isocynates,[150] ketenes,[151] Grignard reagents,[152] phosphites and phosphates,[153] hydrogen cyanide,[154] Barbituric acid,[155] nitrosyl chloride,[156] sulfur,[157] alkyl hypochlorites[158] and dimethyl acetylene dicarboxylate.[159]

Rai and Singh[160] treated cyanogen bromide with $R'CH{=}NC_6H_4R(R'{=}o{-}O_2NC_6H_4CH{=}CH)$. o-$O_2N$-Cinnamalideneaniline to yield crystalline N-bromo-α-cyanoamines(II), which

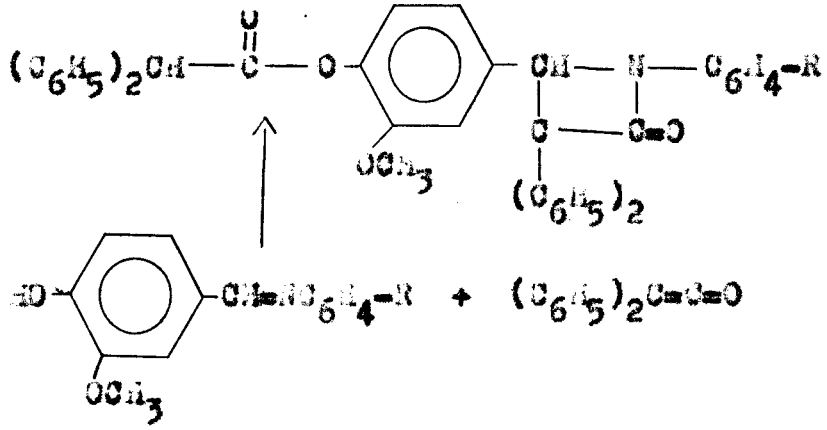
undergo facile dehydrobromination in presence of triethylamine to yield ∝ -cyanoimines(III).



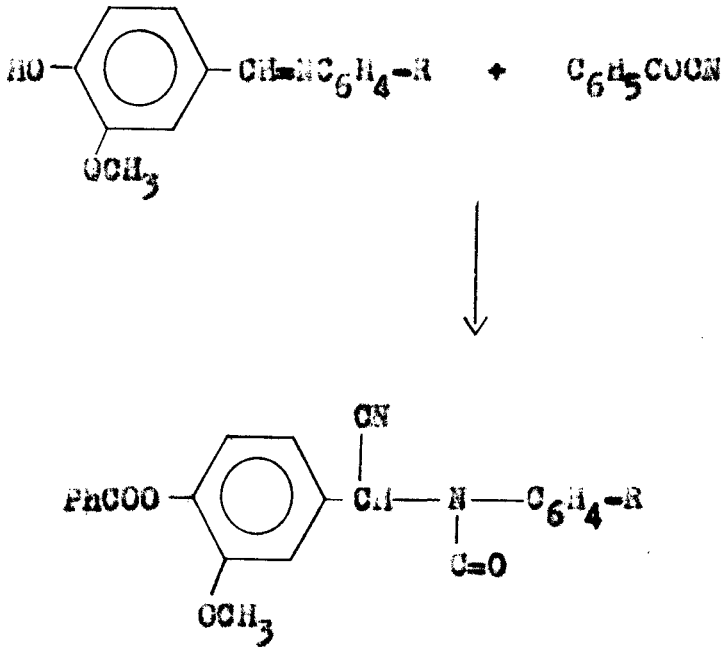
Rai et al.[161] gave the reaction of diphenyl ketene with vanillin Schiff bases generated in situ, react to yield 2-azitidone with simultaneous acylation of hydroxyl group.



(I) (II)



Vanilline Schiff's bases do not yield Reissert Compounds[162] on treatment with benzoyl chloride and aq. KCN but give amides only. However, when benzoyl cyanide is added to the ether solution of vanilline Schiff base,[162(a)] excellent yields of the corresponding Reissert compounds having esterified phenolic group are obtained.



Bruice and Topping[163] have done the catalytic reaction of Schiff's bases. The mechanism for the interconversion of azomethines to amine and ketone as found in the transamination reaction has long held the interest of organic chemist and biochemists alike.

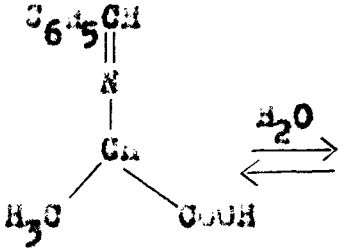
$$R'CHO + NH_2CHR_2 \underset{+H_2O}{\overset{-H_2O}{\rightleftharpoons}} R'CH{=}NCHR_2$$

$$R'CH_2N{=}CR_2 \underset{+H_2O}{\overset{-H_2O}{\rightleftharpoons}} R'CH_2NH_2 + R_2CO$$

The transamination reaction of glyoxalic acid with α-aminophenyl acetic acid was carried out wherein the azomethine formation plays an important role.

$$C_6H_5CHCOOH + CH_3COCOOH \xrightarrow[-H_2O]{100^\circ} C_6H_5CHCOOH$$

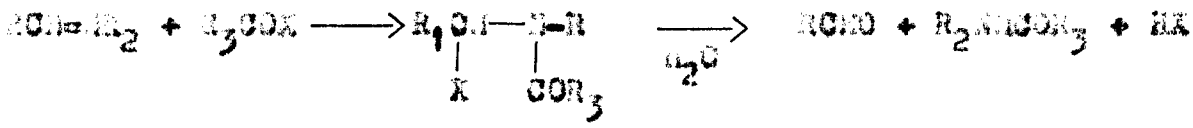
$$\xrightarrow{-CO_2}$$



$$\xrightarrow[]{H_2O} C_6H_5CHO + CH_3{-}CHCOOH$$

Heuser[164] and co-workers have acylated amino acids Schiff bases. Acylating agents react with amino acid Schiff's bases to form intermediates that can be hydrolysed to acylated amino acids or dipeptides. This procedure offers a new method for preparing semi-synthetic penicillins.

It has long been known that the Schiff bases of amines (1) could readily be acylated with acid halides (2) or anhydrides. The reaction involves an addition across the $>C=N-$ to form stable compounds. Subsequent hydrolysis of the acid halide adduct yields the simple acylation product of the original amine.



(1) (2) (3) (4) (5)

Mechanism of Schiff base formation[165]

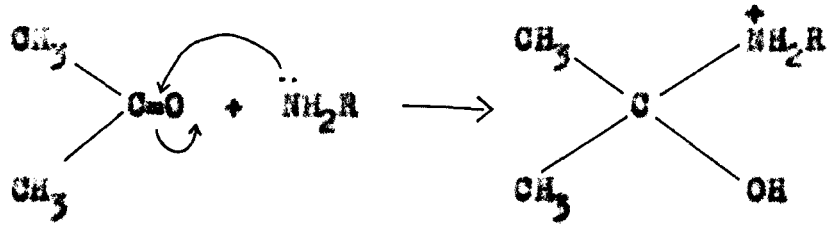
A wide variety of substances with $-NH_2$ group condense with carbonyl compounds to give $>C=N-$ compounds, and water. These reactions usually require acid catalyst.

The dependence of rate of these condensations on acid concentrations is revealing with respect to the reaction mechanism and illustrate several important points relating to acid catalysis. Typically reaction rate goes through maximum with pH, the position of the maximum depending principally on nature of the R of RNH_2. Maximum rate may be observed by considering the possible equilibria involving RNH_2 and CO compounds.

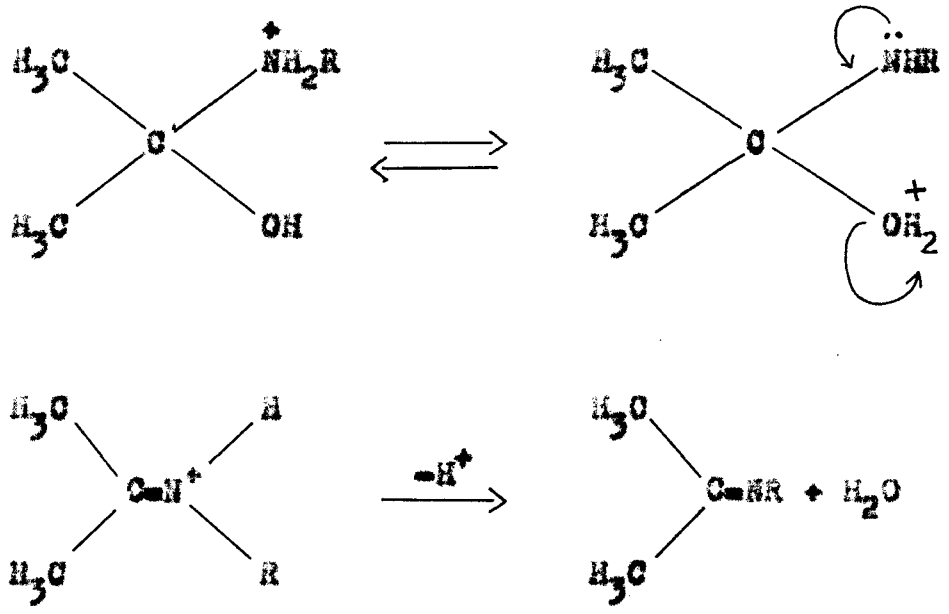
$$RNH_2 + H^+ \rightleftharpoons RNH_3^+$$

$$(CH_3)_2CO + H^+ \rightleftharpoons (CH_3)_2C{=}\overset{+}{O}H$$

The unshared pair of nitrogen of RNH_2 is protonated, it can only then attack the carbonyl group. On the other hand protonation of the CO group should enhance its reactivity towards nucleophilic reagents. The favourable combination of reactant can be represented as under.



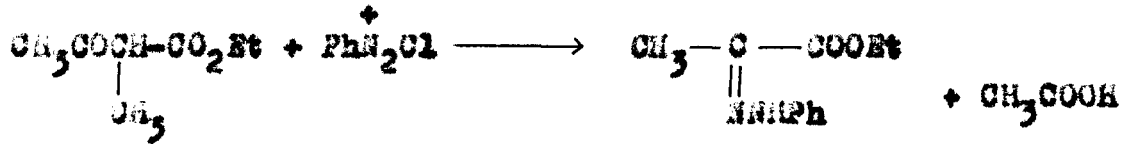
The rest of the steps for the formation of $>C{=}NR$ are usually faster and can be represented by the following sequence of reaction.

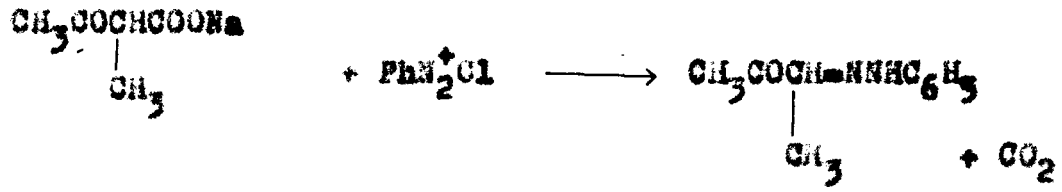


where R may be hydrogen, alkyl or aryl group. Most unsubstituted imines, i.e. R=H, are unstable and polymerizes.

SYNTHESIS OF PHENYLHYDRAZONES

Japp-Klingemann[166] while investigating the nature of coupling products of benzene diazonium chloride and ethylmethyl acetoacetate in alkaline solution obtained the phenylhydrazones of ethyl pyruvate with the elimination of acetic acid. Whereas, the ketonic ester when first hydrolysed by treating with alkali and then coupled, the product was monophenylhydrazone of diacetyl, carbondioxide being removed.





Using this method an unsubstituted β-keto ester such as acetoacetic ester on treatment with a diazonium salt gave α-phenylhydrazone of the corresponding di-ketoester.[167]

$$CH_3COCH_2CO_2Et + PhN_2^+ \longrightarrow CH_3COC(=NNHPh)COOEt$$

Japp-Klingemann reaction has been extensively used by Poefilaktov and his collaborators for the preparation of phenylhydrazones of keto acids.[168-170]

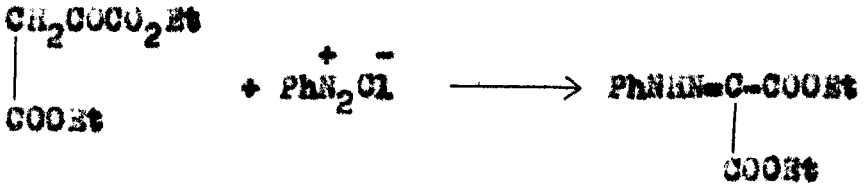
Phillips[171] prepared phenylhydrazones of aldehydes, ketones and keto acids in presence of acetic acid or in aqueous media by treating carbonyl compounds with phenylhydrazine. Favrel[172] also prepared phenylhydrazones of pyruvic acid, α-ketobutyric acid and phenylpyruvic acid by treating them with phenylhydrazine.

Gaudry[173] reported the preparation of phenylhydrazones from thio keto acids.

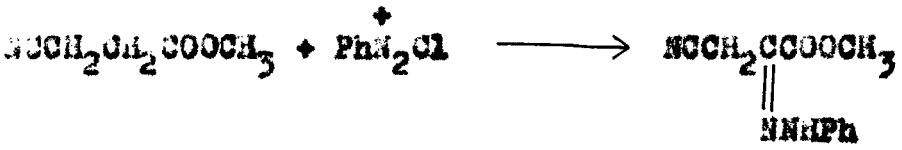
$$C_6H_5CH_2C(=S)COOH + H_2NNHC_6H_5 \longrightarrow C_6H_5CH_2C(=NNHC_6H_5)COOH$$

Favrel[174] prepared phenylhydrazones of ethyl pyruvate and α-ketobutyric acid by the action of benzene diazonium chloride on methyl malonic acid in acetic acid solution. Diethyl oxalacetate also reacts in a similar fashion with one mole of benzene diazonium chloride to give mono-

phenylhydrazone of diethyl diketo succinate.[175-76]



Favrel[174] also synthesised phenylhydrazones of methyl α-keto-β-cyanopropionate by the action of diazonium salt with methyl-β-cyanopropionate in aqueous alkali as well as in acetic acid.

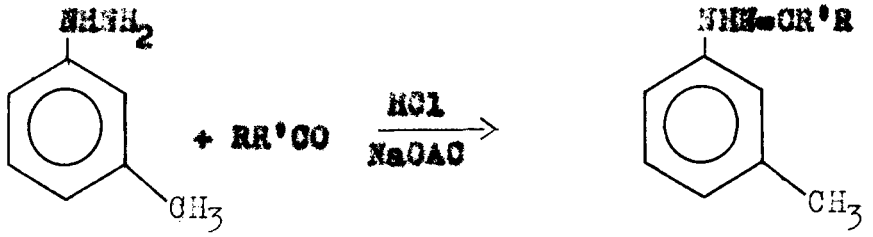


Meltzer et al.[177] prepared ethyl-α-phenylazoaceto-acetate by a different route. They condensed C^{14} acetyl chloride with sodium acetate and resulting product was coupled with phenyl-diazonium chloride in presence of sodium bicarbonate.

4-Methyl coumaran-2-one and p-nitrophenylhydrazine hydrochloride in equimolar proportions reacted in aqueous alcohol to form normal p-nitrophenylhydrazone. In excess of basic reagents in boiling solution, the coumaranone ring

was opened and the di-p-nitrophenylhydrazone of 4-hydroxy-m-tolylglyoxal was formed.[178]

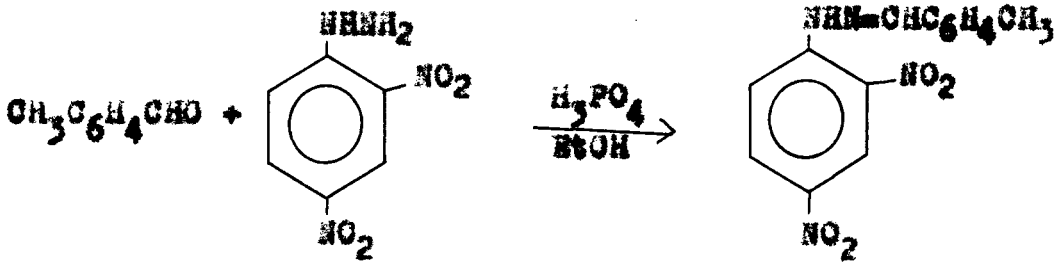
Phenylhydrazones of carbonyl compounds were also synthesised by the condensation of 2,4-dinitrophenylhydrazine with keto compounds using methanol as solvent.[179] m-Tolylhydrazones were also prepared in the following manner.[180]



R' = H, alkyl or aryl group

R = C_6H_5, OHC_6H_4

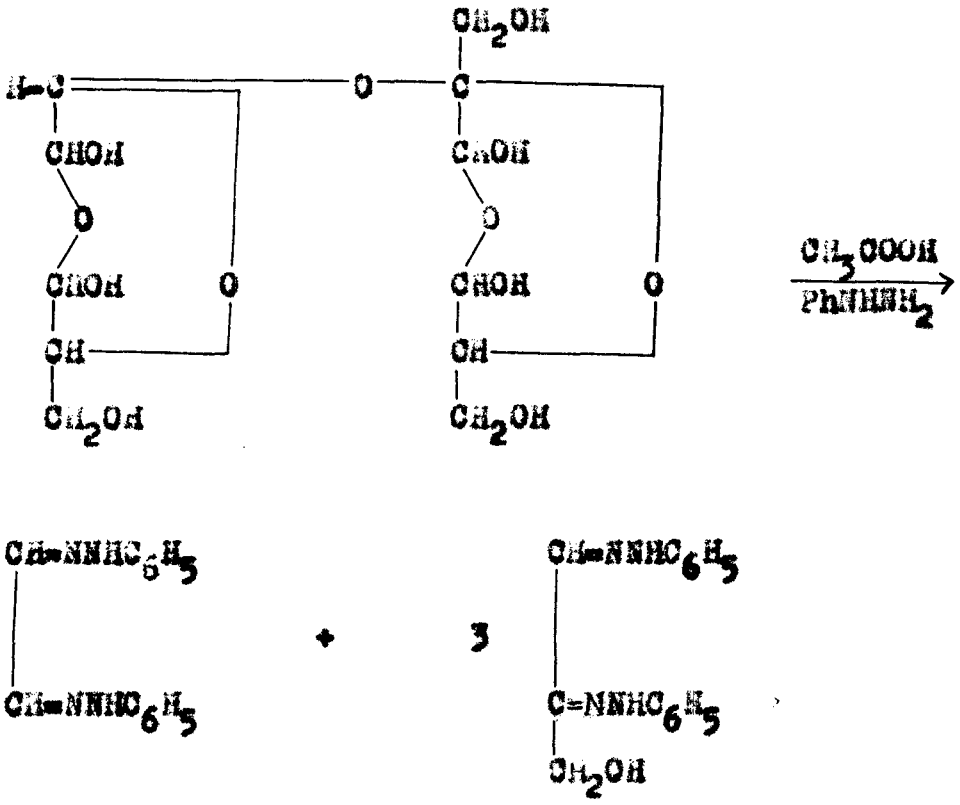
Johnson[181] synthesised various phenylhydrazones of carbonyl compounds by dissolving 2,4-dinitrophenylhydrazine in phosphoric acid solution diluted with water.



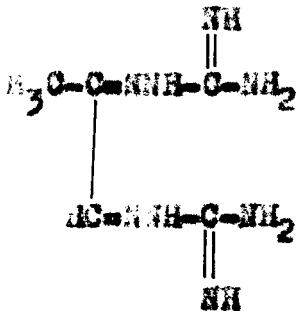
Takagi[182] synthesised pyrimidinylhydrazone of 4-biphenylglyoxal. Substituted phenylhydrazones of ∝-nitrobensaldehyde were also synthesised in the following manner.[183]

$$R\text{-}C_6H_4N_2Cl + C_6H_5CH_2NO_2 \xrightarrow[NaOAc]{AcOH} C_6H_5C(NO_2)\text{=}NNHC_6H_4\text{-}R$$

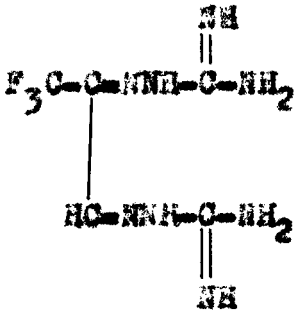
Phenylhydrazones of carbohydrate series have also been synthesised[184-191] with phenylhydrazine in alcohol or aqueous acetic acid solution. Bary et al.[186,187] obtained glyoxal bisphenylhydrazone and glycerosazone from oxysucrose and phenylhydrazine.



Podrebarak and Cheng[192] also prepared a number of alkyl glyoxal bis-(guanylhydrazones) by the reaction of amino guanidine with dichloromethyl alkyl ketone. In addition, the closely related tetrahydroanalog of (I)

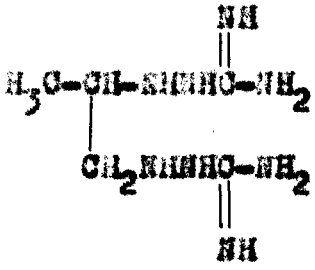


(I)



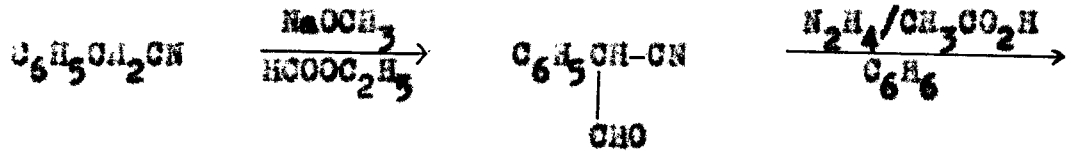
(II)

1,2-bis-(guainidinoamino) propane (III) was prepared by catalytic hydrogenation of (I). These compounds have been shown to possess antileukemic activity.

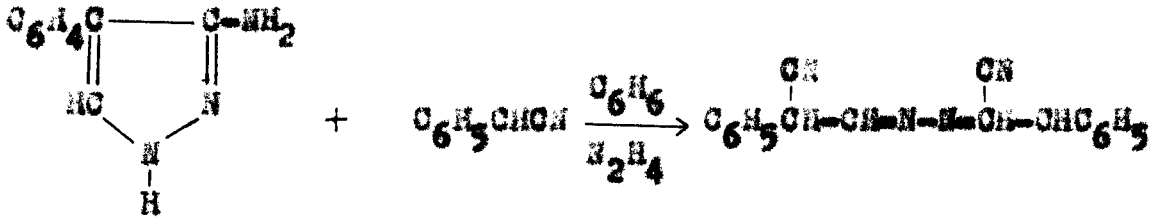


(III)

Anderson et al.[193] have reported the synthesis and muscle relaxant properties of 3-amino-4-arylpyrazoles.

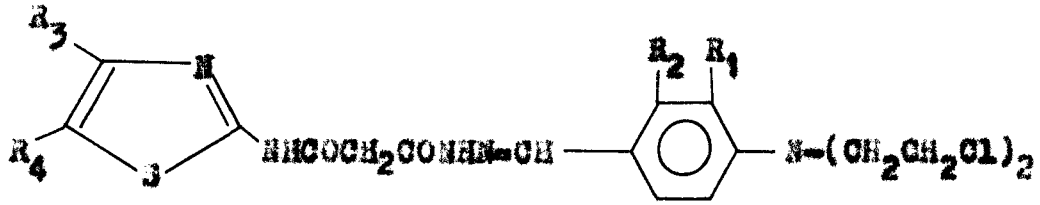


(A) (B)

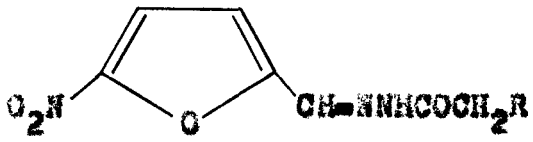


(C) (D)

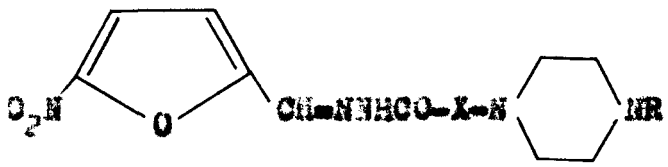
Sabnis and kulkarni[194] described the synthesis of various Schiff's bases from benzaldehyde nitrogen mustard and thiazole amine. Popp[195-197] had reported that several Schiff bases posses antitumor activity against a number of animal tumors. Since CONHN=CH- is a structural modification of the azomethine linkage, it was thought worth while to study whether benzylidene hydrazides from benzaldehyde nitrogen mustard could also be evaluated as potential anticancer agents. Several investigators have described the synthesis of such benzylidene hydrazides.[198-201]



5-Nitro-2-furfuraldehydeaminoacethydrazone as antibacterials[202] was prepared by condensing the 5-nitro-2-furaldehyde with corresponding aminoacethydrazides.

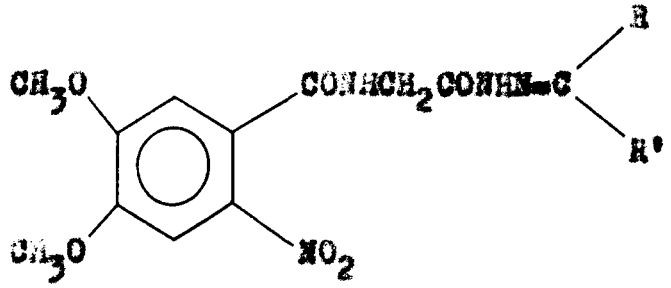


Nardi et al[199] also prepared 5-nitro-2-furaldehyde piperazinoacylhydrazones as antibacterial nitrofuran.



Moreover, the amoebicidal activity of compounds containing -CONH group of haloacetamides has long been known.[203,204]

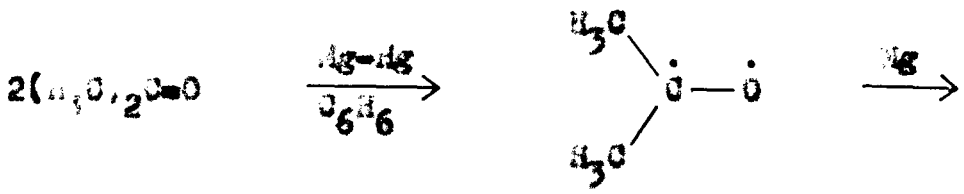
Recently Mishra and co-workers[205] have carried out the synthesis of some new N-(2-Nitro-4,5-dimethoxybenzoyl) glycine hydrazone and evaluated their amoebicidal activity.

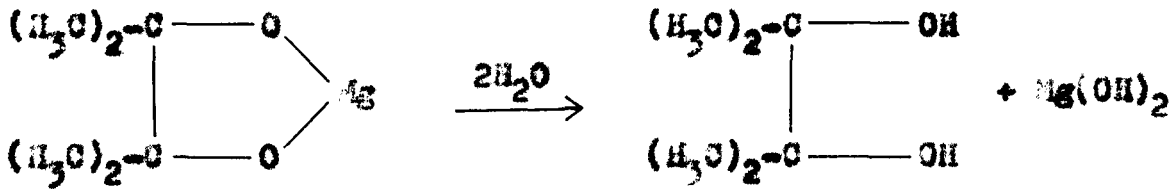


REDUCTIVE DIMERIZATION

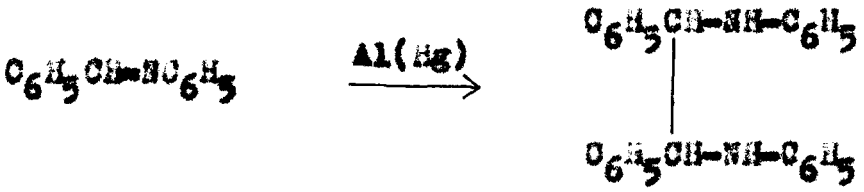
Reduction of aldehydes and ketones can be effected smoothly with borohydrides, by catalytic hydrogenation using Pt, Raney Ni or by sodium alcohol method. Other metal combinations for the reduction of ketones such as magnesium, magnesium amalgam, zinc, zinc amalgam or aluminium amalgam in the absence of protonic solvents, leads to the production of anion or free radicals in sufficiently high concentrations. Coupling of these anions or free radicals leads to the formation of bimolecular products.

Adams and Adams[206] gave the standard laboratory method for the preparation of pinacols by the reduction of dry acetone with amalgamated magnesium in benzene followed by the hydrolysis of the magnesium derivative formed.





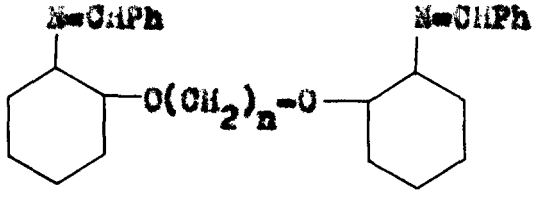
Anselmino[207] prepared 1,2-diphenyl 1,2-diamino-phenylethane (II) by the reduction of benzalaniline(I) with aluminium amalgam in ether.



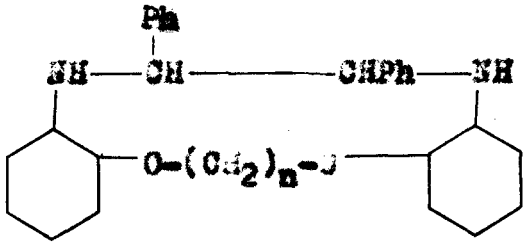
(I) (II)

The reduction product obtained by the use of Al/Hg resembles in its mode of formation with pinacols, it is a bimolecular reduction product and is conceived as a hydrazobenzoin or dibenzal derivative.

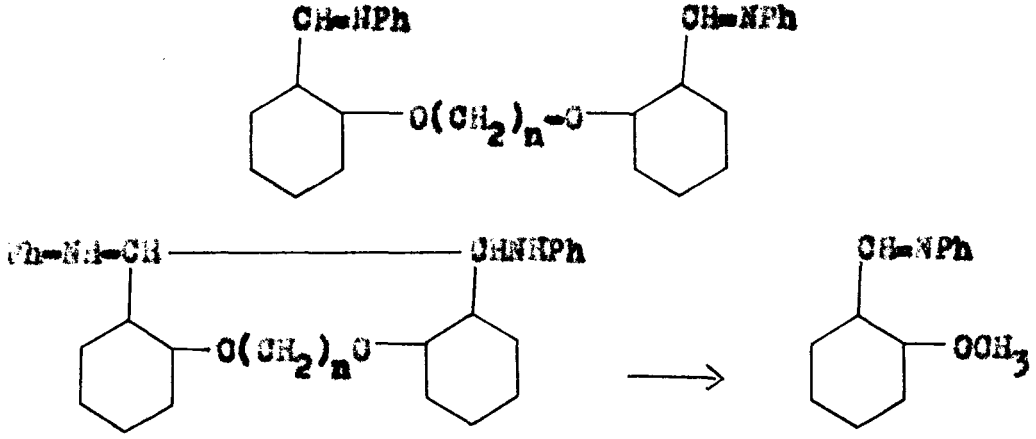
N-o-Methoxybenzylidenemaniline is reduced to 1,2-dianiline-1,2-di-o-methoxyphenylethane in 90% yield, using sodium and toluene. Both the meso and racemic isomers were isolated.[208,209]



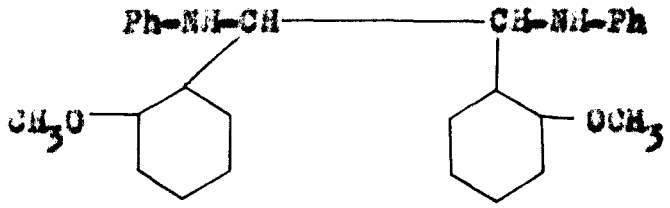
(I)



(II)

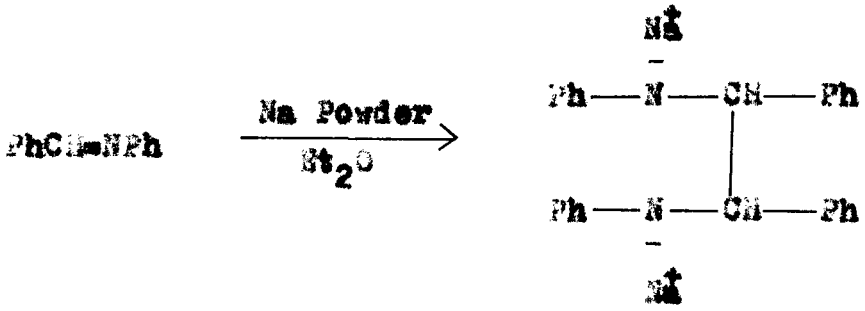


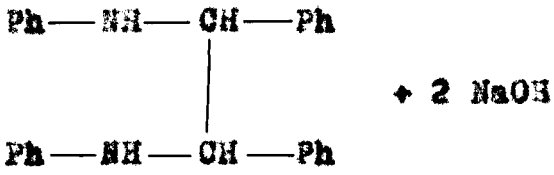
(IV) (V)



Appenrodt et al.[210] showed that under proper conditions, certain compounds containing $>C=C<$, $>C=N-$, $-N=N-$ and $-\underset{|}{C}=N-$ groups can add alkali metals. These experiments were carried out in Et_2O in an atmosphere of

nitrogen in a sealed tube, the sodium being in the form of powder. In some cases reaction starts immediately in other cases after shaking for several days, characteristics of an induced reaction. Starting from benzalaniline, they obtained diazoanilinodiphenylethane$(PhN{=}CHPh)_2$.

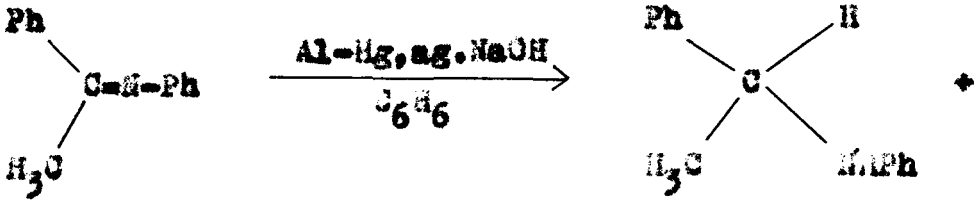


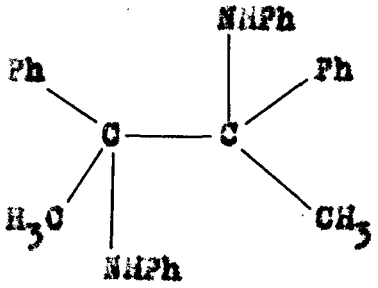


Bilman[211] reduced Schiff's bases rapidly by dimethylaminoborane in acetic acid solution or suspension. Unlike other borohydrides dimethylaminoborane can be used in boiling acetic acid with little loss of active hydrogen. However, dimer formation was not observed.

$$3C_6H_5CH{=}NC_6H_5 + (CH_3)_2NHBH_3 + 3CH_3COOH \xrightarrow{34.6} 3C_6H_5CH_2NHC_6H_5 + (CH_3)_2NH + (CH_3COO)_3B$$

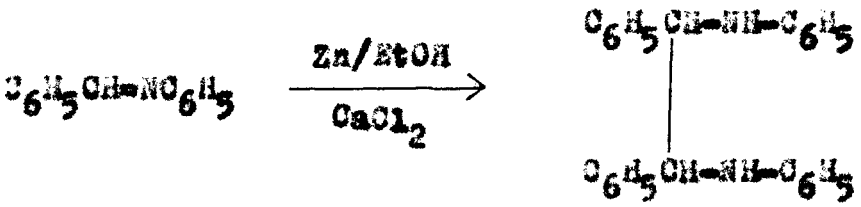
Schiff's bases derived from methyl ketones can be reduced to amines using sodium alcohol, or aluminium amalgam and tin hydrochloride. Dimer production frequently observed,[212] can be easily represented by the following equation.





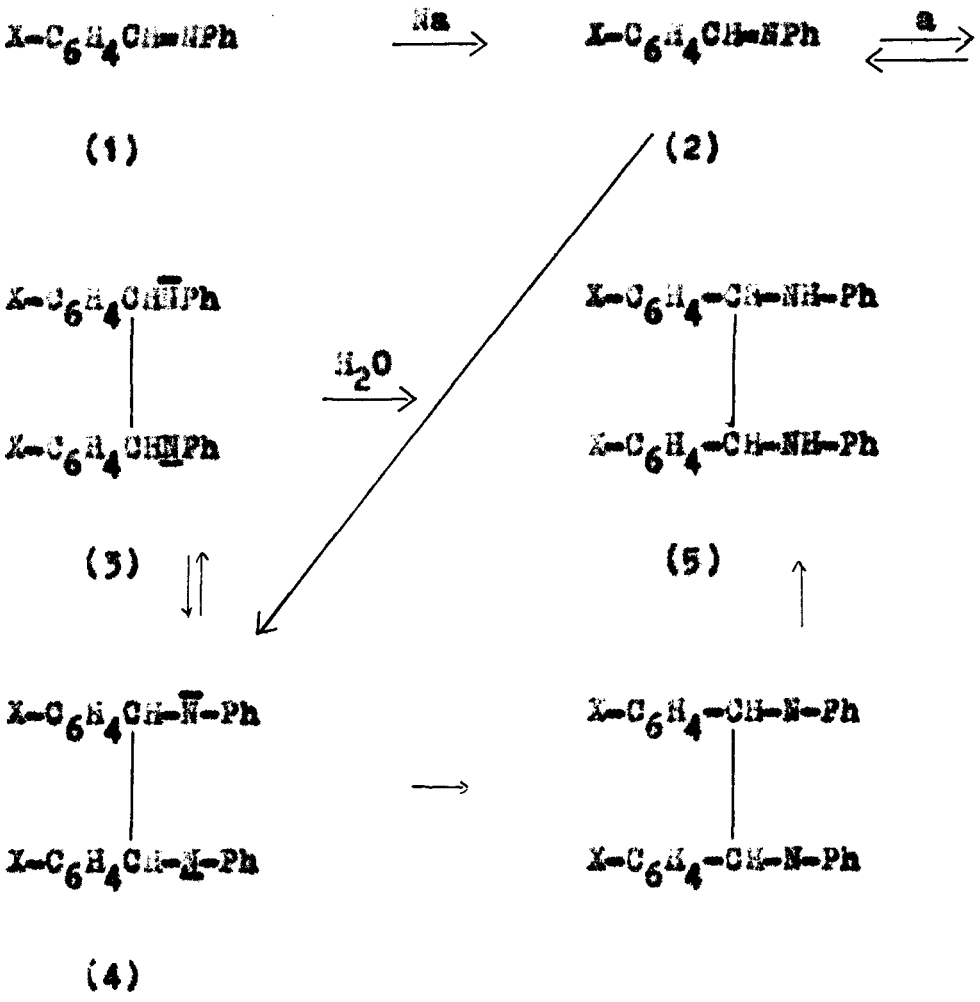
Kidwai and Khan[213] studied the reduction of compounds containing $>C=N-$ group and observed that benzalaniline when treated with zinc and calcium chloride in alcohol, undergoes the bimolecular reduction to 1,2-diphenyl-1,2-diaminophenylethane, in 75% yield, instead of simple addition of hydrogen atom to form N-benzylaniline. They found that 1,2-diphenyl-1,2-diaminophenylethane is

known to exist in two modifications, one melting at 173° and the other at 164°. These modifications were isolated from the reaction mixture.

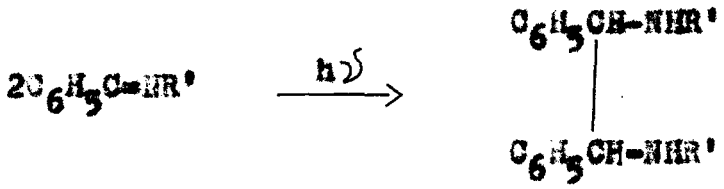


They further showed that iron and ferric chloride also reduces benzalaniline to dimerized product but in poor yield. The yield of bimolecular reduction product using zinc dust and $CaCl_2$ in (75%), and can be improved by changing the amount and the nature of solvent.

Smith and Ho[214] reported the reductive dimerization of Schiff's bases by alkali metals to 1,2-diaryl-N, N'-diphenylethelenediamines. The alkali metal induced reductive dimerization of substituted N-benzalanilines (ArCH=NPh) in ether solvent is examined. Particular attention is directed towards the isomerization of the diastereomeric mixtures of dimeric dianions which are the primary products of the reaction, by means of cross product experiments.



Photochemical studies of imines suggested that many of the reported reactions actually do not involve a photo exited state of the imine. Aryl amines have been shown to undergo reduction[215,216] and reductive dimerisation[217] on photolysis via an α-amino radical formed by hydrogen atom transfer to the imine from an α-hydroxy radical initially formed by the abstraction of a hydrogen atom from the solvent by the sensitiser.



a, R = H, R' = $(CH_2)_2CN$

b, R = H, R' = $(CH_2)_2CH{=}CH_2$

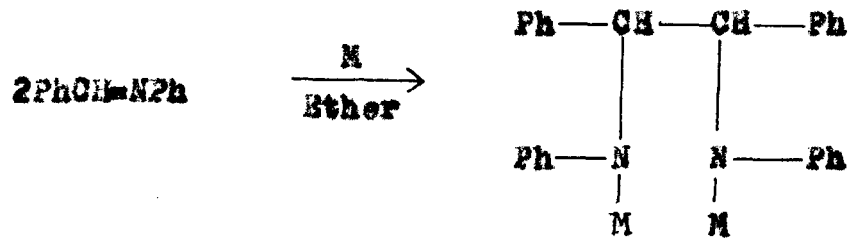
c, R = H, R' = $(CH_2)_3NHCOCH_3$

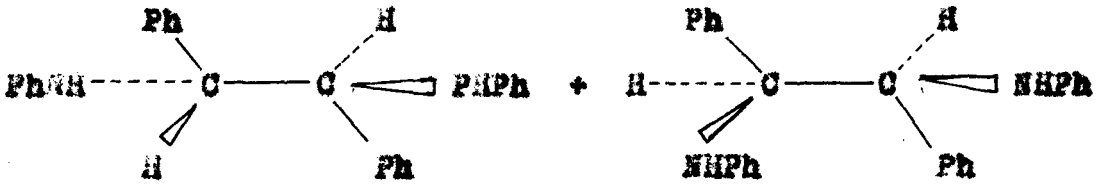
d, R = H, R' = $(CH_2)_2NHCOC_6H_5$

e, R = H, R' = $(CH_2CH(OH)C_6H_5$

f, R = CH_3 R' = $(CH_2)_2CN$

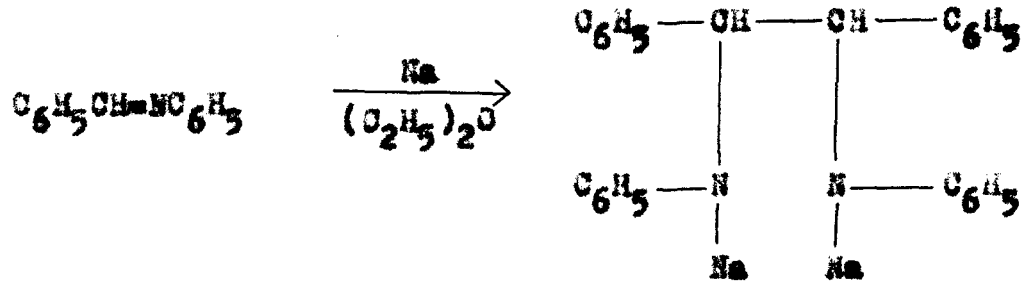
Smith and Veach[218] showed that under certain conditions the reduction of N-benzylideneaniline proceeds with dimerisation to give a diastereomeric mixture of N,N',1,2-tetraphenylethylenediamines. This reaction occurs with alkali metals[219,220] magnesium,magnesium iodide[221,222] and aluminium amalgam[207,223] as reducing agents. It has been reported[223] that the reduction products is approximately a 50:50 mixture of the two diastereomeric diamines.



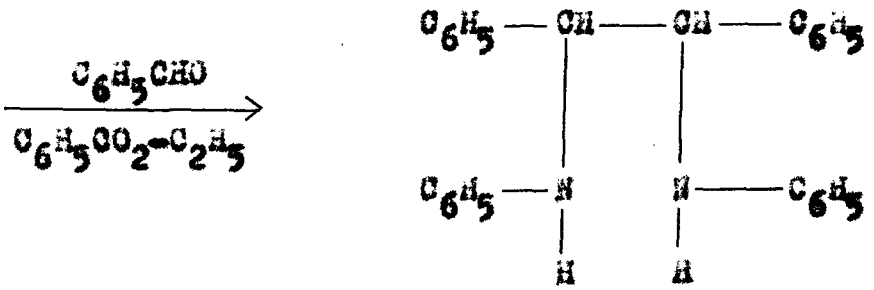


meso dd,ll

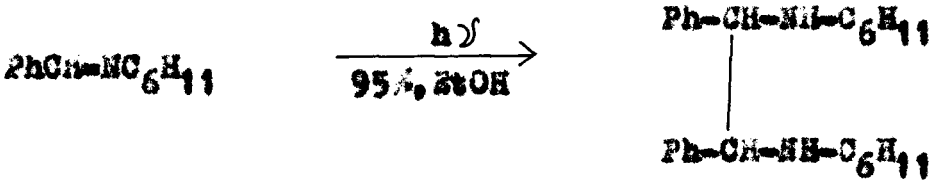
Smith[224] reported the synthesis of 1,2,3,4-tetraphenyldiazetisine by treating the sodium adduct of N-benzylideneaniline with benzaldehyde or benzoate ester. It has been shown that the original report[216] is in error.



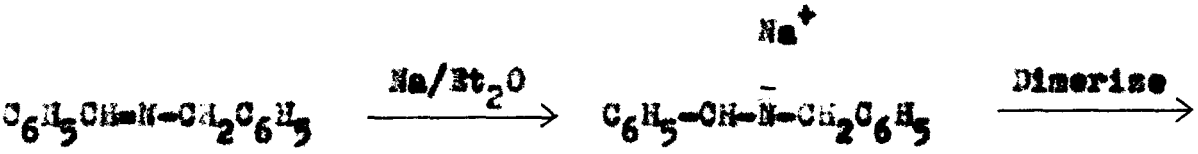
(I)

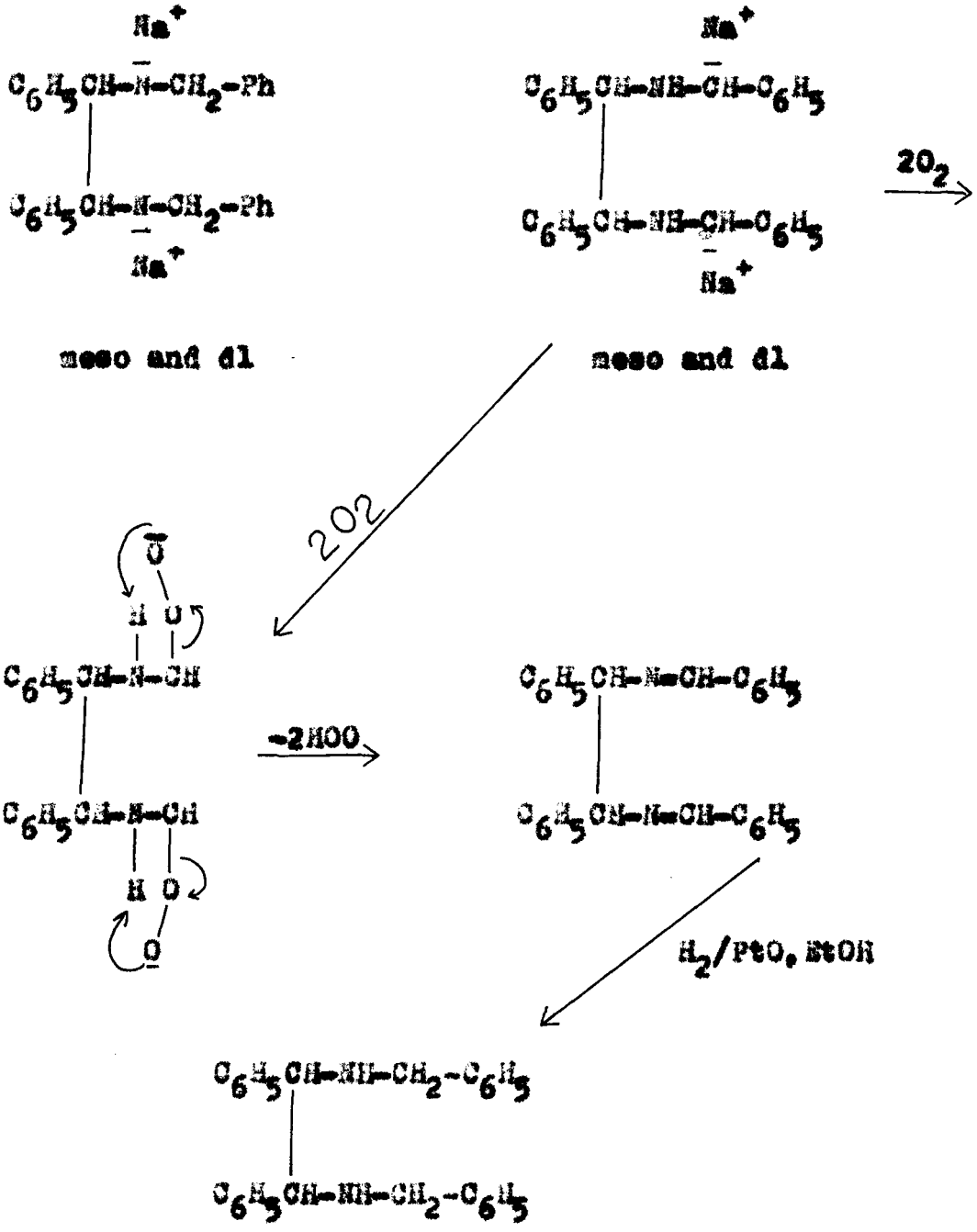


Padawa et al.[225] described the mechanism and scope of the photoreduction of some aryl N-alkylimines. Irradiation of a series of benzaldehyde N-alkylimines in 95% ethanol affords dihydrophotodimers, whereas irradiation of several benzophenone N-alkylimines gives the reduced benzhydrylalkylimines. The excited states of the imines were shown not to be reactive intermediate but instead ketyl radical were clearly implicated as the active reducing agent. These ketyl radicals were derived from carbonyl compounds present in the reaction mixture as an impurity, and added sensitizer, or as a photogenerated species.



Mehrotra and Siri[226] performed the reaction of Na with benzaldehyde N-benzylimine in dry ether followed by bubbling oxygen and decomposition of the metal salt giving meso and dl dialdimines.





Mehrotra and Singh[227] have reported the photolysis of benzaldehyde N-benzhydrylimine(I) in 95% ethanol giving

meso and dl modifications of N,N'-dibenshydryl-1,2-diphenyl-1,2-diaminoethane.

$$(C_6H_5)_2CH\text{-}N{=}CHC_6H_5 \xrightarrow[95\%\ EtOH]{h\nu} \begin{matrix}(C_6H_5)_2CH\text{-}NH\text{-}CH\text{-}C_6H_5\\ |\\ (C_6H_5)_2CH\text{-}NH\text{-}CH\text{-}C_6H_5\end{matrix}$$

(I) Meso and dl (II)

Mehrotra and co-workers[228] have also done the photo reduction of benzophenone N-alkylimine to benshydryl alkylamines.[247] This study showed that the presence of 1,1,2,2-tetraphenylethylamine as one of the photoreduction products of benzophenone N-benzhydrylimine.

$$(C_6H_5)_2C{=}N\text{-}CH(C_6H_5)_2 \xrightarrow[95\%\ EtOH]{h\nu} (C_6H_5)_2\text{-}\underset{\displaystyle NH_2}{\overset{|}{C}}\text{-}CH(C_6H_5)_2$$

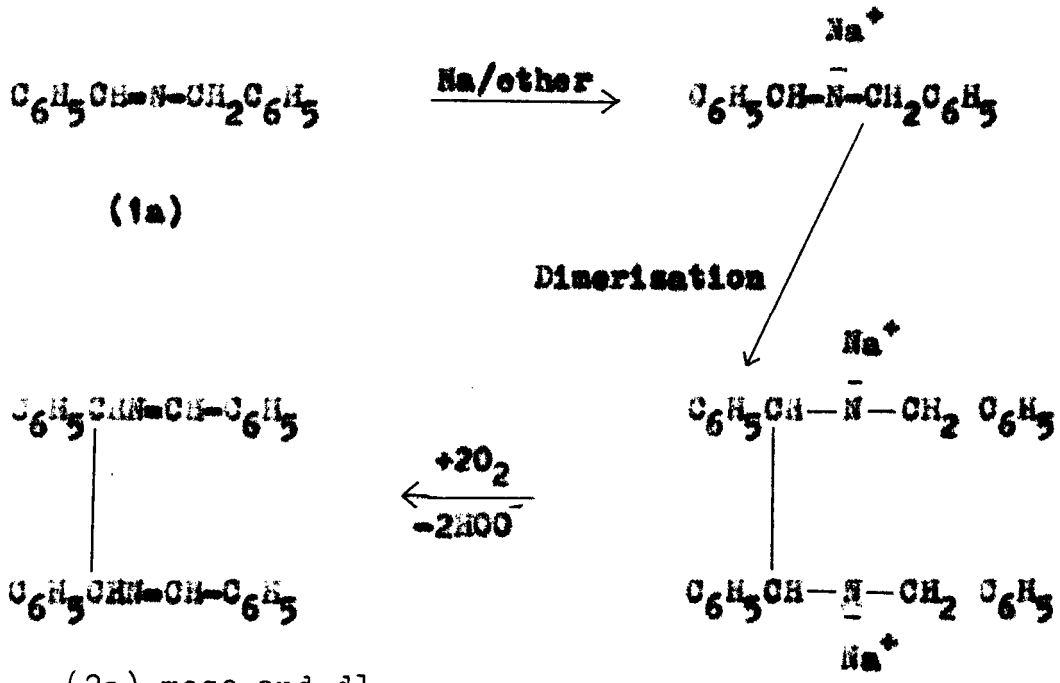
(I) (II)

$$\xrightarrow[-NH_3]{Ac_2O/AcOH} (C_6H_5)_2C{=}C(C_6H_5)_2$$

(III)

Childs et al.[229] reported the isomerisation of Schiff's bases by irradiation in F_3CCOOH or H_2SO_4, to get 35% yield of isomerised product.

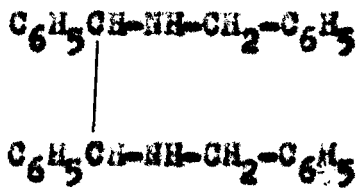
Giri et al.[230] represented the new and convenient route to the synthesis of diimines and substituted aryl diazomethanes of N-substituted imines and ketone hydrazone in presence of sodium in ether. The product obtained with benzaldehyde N-benzylimine (1a, Ar=Ar'=C_6H_5, R=H) was seperated by repeated fractional crystallisation from ethanol. It consisted of meso and dl-N,N'-dibenzylidene-1,2-diphenylethylenediamine (2a; 17% each). Authentic samples of meso and dl-2a were prepared according to the method reported.[231] Catalytic hydrogenation of meso and dl-2a gave meso and dl N,N'-dibenzyl-1,2-diphenyl-1,2-diaminoethane.[232]



(1a)

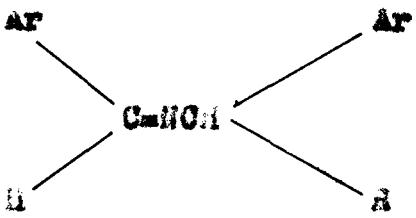
(2a) meso and dl

(2a) $2H_2/PtO_2$ →



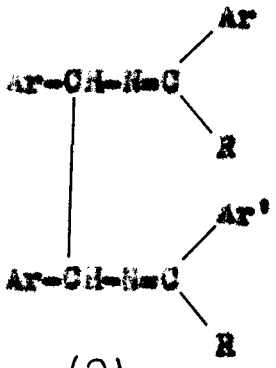
meso and dl

Ketone hydrazone on similar treatment, as described for imines, gave substituted diazomethanes in 88-85% yeild.



(1) Na/Ether
(ii) O_2
(iii) Aq.NH_4Cl →

(1)



(2)

D I S C U S S I O N

Nitrogenous compounds are important chemotherapeutic agents. They are used as fertilizers and industrial raw materials for the production of various synthetic polymers.

Schiff's bases have gained prominence as important pharmaceuticals. Some of them have anticancer and anti-tuberculostic activities. They are used as potent drugs for many diseases including heart ailments. They produce vasodilation, possess antipyretic and antiseptic properties. Schiff bases having anticancer properties have been prepared by the condensation of aniline with disubstituted benzaldehydes. Thiazole and benzothiazole derivatives are also reported as biologically active compounds. Schiff bases from benzaldehyde, nitrogen mustard and *p*-aminophenylthiazole are reported to have significant activity against cancer.

Some Schiff bases have shown fungistatic activity and act as stimulant for central, and peripheral nervous system. A number of azomethines of aliphatic aldehydes were tested for antibacterial activities. These compounds have also been used as anti-inflammatory, antirheumatic, antiallergic and antihemolytic agents. A large number of these compounds are associated with anticonvulsant and psychotropic properties.

With the realisation of innumerable biological properties associated with Schiff bases, we have synthesised a number of Schiff bases (I-XXIV). Their bimolecular products

were also synthesised in order to study the effect of increase of nitrogen on their potentialities as drug. Several phenylhydrazones (XXV-XLIII) were synthesised with a motive to prepare their dimerised products and to study their biological activities.

Synthesis of Schiff's Bases

Schiff bases or imines of carbonyl compounds were prepared according to the method of Bigelow and Eatough.[21] One mole of an appropriate aldehyde, ketone or keto acid was treated with one equivalent of freshly distilled aniline in presence of acetic acid at room temperature or steam bath temperature for varying length of times (30 min. to 2 hr.). Schiff's bases of carbonyl compounds were easily obtained in crystalline form on cooling. These compounds were recrystallised using suitable solvent, filtered and dried in a vacuum dessicator over anhydrous calcium chloride. The liquid imines were taken in ether, washed successively with sodium bicarbonate solution (5%) and water. Ether solution was dried over anhydrous sodium sulphate, filtered and concentrated under vacuo to obtain Schiff bases. (Table-1)

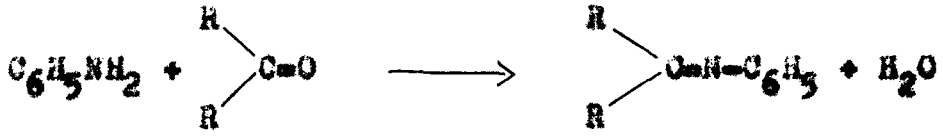
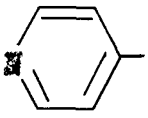
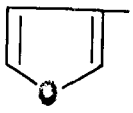
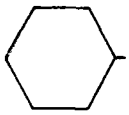


TABLE - 1

COMPOUND NO.	R	R´	YIELD (%)	M.P. °C
(I)	C_6H_5-	H	95	55
(II)	$(H_3C)_2N.C_6H_4$-	H	93	95
(III)	2.$(H_3CO)C_6H_4$-	H	90	65-66
(IV)	3,4-$(H_3CO)_2C_6H_3$-	H	88	99-100
(V)	4.$(O_2N)C_6H_4$-	H	79	98
(VI)	2.$(HO)C_6H_4$-	H	82	69
(VII)	2.$(O_2N)C_6H_4$-	H	75	102
(VIII)	2,4-$(OH)_2C_6H_3$-	H	89	91-92
(IX)	3,4,5-$(H_3CO)_3C_6H_2$-	H	78	120
(X)	4.$(OH)C_6H_4$-	H	92	83-84
(XI)	$CH_3CH=CH$-	H	72	—
(XII)	$CH_3CH_2CH_2$-	H	77	—
(XIII)	CH_3-	H	82	—
(XIV)	$C_6H_5CH=CH$ -	H	83	88-90
(XV)		H	79	86-87
(XVI)		H	77	93-94

COMPOUND NO.	R	R´	YIELD (%)	M.P. °C
(XVII)	C_6H_5-	$-C_2H_5$	75	—
(XVIII)	C_6H_5-	$-CH_3$	78	—
(XIX)		H	85	—
(XX)	C_2H_5-	$-CH_3$	87	—
(XXI)	CH_3-	$-CH_3$	88.5	—
(XXII)	$HO_2C(CH_2)_2$-	$-CH_3$	79	102-3
(XXIII)	$HO_2C(CH_2)_2$-	$-CO_2H$	80	132-33
(XXIV)	HOOC-	$-CO_2H$	82	129-30

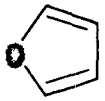
Synthesis of Phenylhydrazones

Phenylhydrazones of keto compounds were prepared using the standard method of Phillip.[171] One mole of alcoholic or aqueous solution of an aldehyde, ketone or keto acid was treated with one mole equivalent of phenylhydrazine solution at room temperature or on a water bath for a period ranging from five minutes to 1 hr. Phenylhydrazones of aldehydes, ketone or keto acids were obtained easily in crystalline form. The reaction mixture was cooled filtered and washed with water and air dried. This was recrystallised using a suitable solvent, to get pure phenylhydrazones.(Table-2)

$$C_6H_5NHNH_2 + \acute{R}R\ C{=}O \xrightarrow{-H_2O} C_6H_5NHN{=}C(R\acute{R})$$

(II)

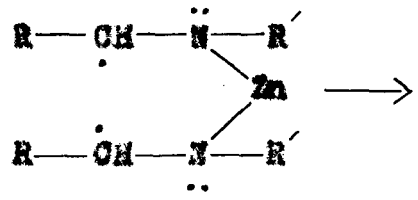
TABLE-2

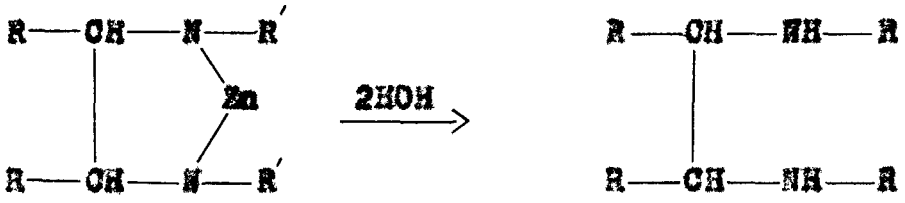
COMPOUND NO.	R	R´	YIELD (%)	M.P. °C
(XXV)	C_6H_5-	H	98	145-46
(XXVI)	4-$(O_2N)C_6H_4$-	H	95	156
(XXVII)	4-$(H_3C)_2NC_6H_4$-	H	97	148
(XXVIII)	2-$(HO)C_6H_4$-	H	95.5	139-40
(XXIX)	4-$(HO)C_6H_4$-	H	93	120
(XXX)	3,4-$(H_3CO)_2C_6H_3$-	H	95	118
(XXXI)	$(O_2N)C_6H_4$-	H	73	143
(XXXII)	4-(OH)-3-$(H_3CO)C_6H_4$-	H	78	173
(XXXIII)	$C_6H_5CH{=}CH$ -	H	92	155-57
(XXXIV)	4-$(H_3CO)C_6H_4$-	H	93	116-117
(XXXV)		H	84	169-70
(XXXVI)		H	83	158

COMPOUND NO.	R	R´	YIELD (%)	M.P. °C
(XXXVII)	HOOC -	COOH	89	186-87
(XXXVIII)	$HO_2C(CH_2)_2$-	COOH	85	179-80
(XXXIX)	$HO_2C(CH_2)_2$-	CH_3	88	118-19
(XL)	HO_2C -	H	93	129-30
(XLI)	$HO_2CC_6H_4$-	H	94	127
(XLII)	H_3C -	CH_3	85	92-93

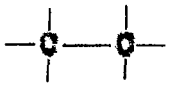
Schiff's bases and phenylhydrazones of carbonyl compounds were subjected to chemical reduction using zinc dust and ethanol-chloroform mixture (20:1) under reflux for varying lengths of time yielding substituted bimolecular reduction products (XLIII-LXXXIV) in quite encouraging yields. Mechanism of formation of bimolecular products may be explained by the following sequence of reaction.

$$2R\text{-}CH\text{=}N\text{-}R' \xrightarrow[2e+Zn^{2+} = Zn \text{ metal}]{+2e}$$





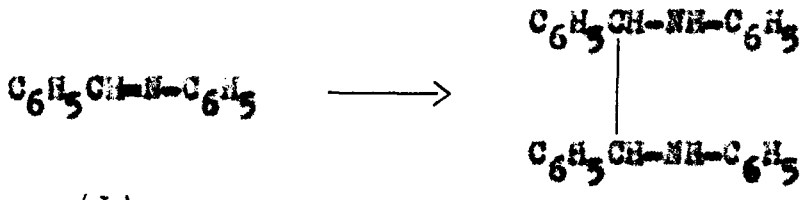
Formation of a covalent bond takes place between the two free radicals, resulting in the formations of a



bond.

Reaction of Benzalaniline (I) with Zinc Dust and Ethanolic Chloroform

Reduction of Schiff's base (I) was carried out at reflux temperature using zinc dust in ethanol-chloroform mixture (20:1) for 4.5 hr. Work-up of the reaction mixture and crystallization gave the compound m.p. 130°.



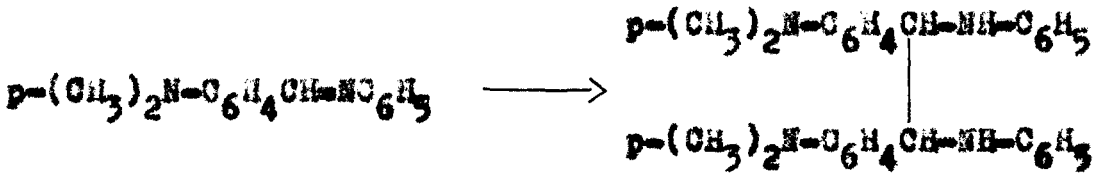
(I) (XLIII)

Characterization of the Compound m.p. 130° as 1,2-diphenyl-1,2-diaminophenylethane(XLIII)

The compound m.p. 130° gave analysis for $C_{26}H_{24}N_2$ and its molecular weight was found to be 364. UV spectrum gave a strong band at 245 nm. IR spectrum showed absorption bands at 3145—3220 (NH), 3020 (C=C-H), benzene ring, 1600, 1585 (C=C), 1450 (C-N) and 740, 700 cm^{-1} (mono-substituted benzene). The NMR spectrum of this compound gave a multiplet at δ7.00 - 7.25 for 20 aromatic protons. A broad singlet for 2 protons at δ4.58 was assigned to the benzylic protons. A broad doublet like signal for two protons observed at δ5.7 (diminished on D_2O shake) was ascribable for amino protons. Above studies confirmed the structure of the compound m.p. 130° as (XLIII).

Reaction of p-dimethylaminobenzalaniline(II) with Zinc Dust and Ethanolic Chloroform.

Reduction of the substrate (II) with zinc dust and ethanolic chloroform at reflux temperature gave bimolecular reduction product; m.p. 195°.



(II) (XLIV)

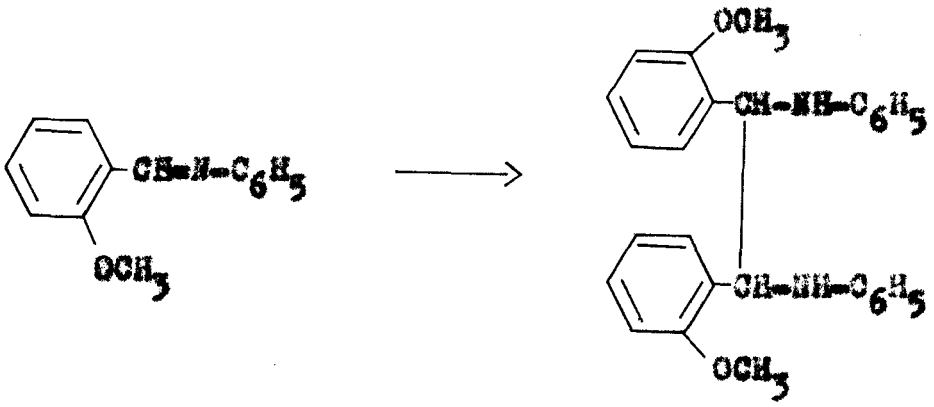
Characterization of the compound (XLIV) m.p. 195° as 1,2-di-(4-dimethylaminophenyl)-1,2-diaminophenylethane(XLIV).

Elemental analysis and molecular weight determination of (XLIV) confirmed molecular formula as $C_{30}H_{34}N_4$. It gave UV absorption maximum at 332 nm. IR spectrum displayed bands at 3240-3200 (NH), 3015 (C=C—H), 1600, 1575, 1540 (C═══C), 1440, 1390 (C—N) and 730, 700 cm^{-1} (disubstituted benzene). This clearly indicated the formation of a bimolecular product (XLIV). NMR spectrum of this compound further substantiated the above structure. A multiplet for 18 protons seen between δ 7.3 - 7.8 can be assigned to the aromatic protons. A broad singlet appearing at δ 4.6 was due to two benzylic protons. A broad doublet like signal for two protons exchangeable with D_2O is seen for two amino

protons. A peak observed at δ3.25 was ascribable for 6 protons of N-dimethyl group.

Reaction of 2-Methoxybenzalaniline(III) with Zinc Dust and Ethanolic Chloroform

The reaction of 2-methoxybenzalaniline (III) with zinc dust in ethanolic chloroform provided a compound m.p. 190°.



(III) (XLV)

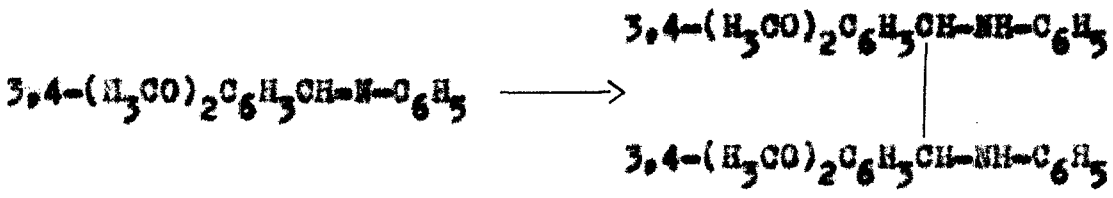
Characterisation of the compound m.p. 190° as 1,2-di-(2-methoxyphenyl)-1,2-diaminophenylethane(XLV)

Compound m.p. 190° was correctly analysed for $C_{28}H_{28}N_2O_2$ through elemental analysis and molecular weight determination. IR spectrum of this compound showed absorption bands at 3240-3150 cm^{-1} (NH); 3030 (C=C—H); 1585, 1560 (C=—C); 1385 (C—N), 1250 (C—O) and 750 cm^{-1} (disubstituted benzene). NMR spectrum exhibited a singlet

for 6 H at δ3.50 which can be assigned to o-methoxy protons on the benzene ring. A broad singlet at δ 4.72 was observed for two benzylic protons. A multiplet at δ 7.1 - 7.6 was seen for 18 aromatic protons. On the basis of above observations the compound m.p. 190° was assigned the structure (XLV).

Reaction of 3,4-Dimethoxybenzalaniline(IV) with Zinc Dust and Chloroform

Compound (IV) was refluxed with zinc dust and chloroform yielding a compound melting at 195°.



(IV) (XLVI)

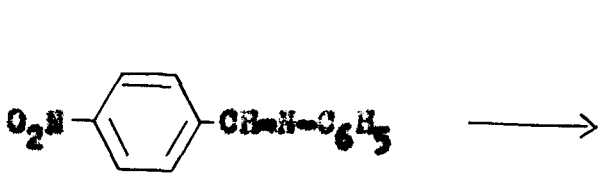
Characterisation of the Compound m.p. 195° as 1,2-di-(3,4-dimethoxyphenyl)-1,2-diaminophenylethane(XLVI)

Compound m.p. 190° was correctly analysed through elemental analysis and molecular weight determination for $C_{30}H_{32}N_4O_2$. UV spectrum showed absorption maximum at 236 nm. IR bands of this compound were seen at 3240—3180 (NH), 3010 (C=C—H) and 1600, 1540 cm^{-1} (C=—C) for benzene rings. Bands at

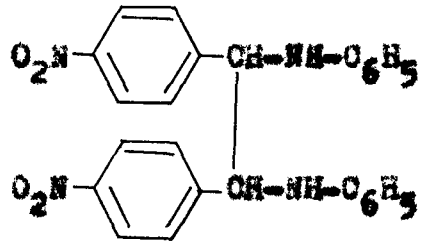
1380 and 880 cm^{-1} can be assigned to (C—H) and trisubstituted benzene. NMR spectrum of this compound further substantiated the structure (XLVI). A multiplet at δ6.8 - 7.2 for 16 protons of aromatic ring, a doublet for 2 protons at δ 4.70 is ascribable for the benzylic protons. A doublet like signal due to 2 amino protons observed at δ 5.9 was found to be exchangeable with D_2O. A broad signal for 12 H observed at δ 3.6 was assigned for four methoxy protons. On the basis of these observations the product m.p. 195° was assigned structure as 1,2-di-(3,4-dimethoxyphenyl)-1,2-diaminophenylethane (XLVI).

Reaction of 4-Nitrobensalaniline(V) with Zinc Dust and Chloroform

Reduction of 4-nitrobensalaniline (V) with zinc dust and chloroform carried out in the usual way, provided a compound m.p. 160-61°.



(V)



(XLVII)

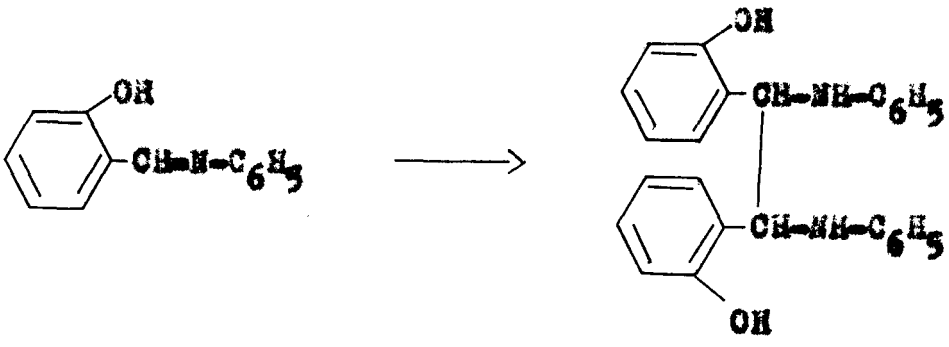
Characterisation of the compound m.p. 160-61° as 1,2-di-(4-nitrophenyl)-1,2-diaminophenylethane(XLVII)

Compound m.p. 160-61° was correctly analysed for $C_{26}H_{22}N_4O_4$. UV absorption maximum of this compound appeared

at 285 nm. IR spectrum of this compound showed bands at 3230—3210 for (NH) group, while absorption bands at 3020, (C═C—H), 1600, 1590 cm^{-1} (C═C) are for benzene ring. Bands at 1370 and 750 cm^{-1} are for C—N and disubstituted benzene. The N.M.R spectrum supports this structure. A multiplet for 18 protons appeared at δ 7.30 - 7.8 was ascribable to aromatic protons. A broad singlet for two benzylic protons was observed at δ 4.86. A broad doublet for two protons seen at δ 6.00 (disappearing on D_2O shake) was assigned to amino protons. On the basis of elemental analysis, molecular weight and spectral studies, the compound melting at 160-61° was assigned the structure (XLVII).

Reaction of 2-Hydroxybenzalaniline(VI) with Zinc Dust and Ethanolic Chloroform

Treatment of compound (VI) with zinc dust and ethanolic chloroform was performed in the usual fashion, yielded a compound, m.p. 165°.



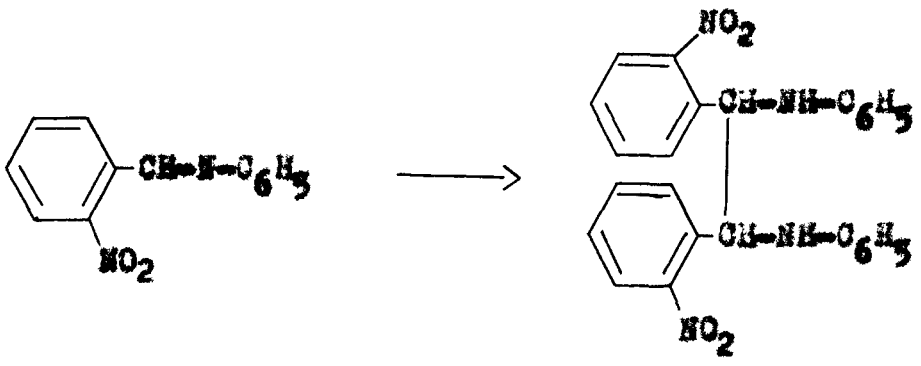
(VI) (XLVIII)

Characterisation of the Compound m.p. 165° as 1,2-di-(2-hydroxyphenyl)-1,2-diaminophenylethane(XLVIII)

The compound melting at 165° gave elemental analysis for $C_{26}H_{24}N_2O_2$. UV absorption maximum was observed at 250 nm. IR spectrum exhibited bands at 3230-3150 cm^{-1} for (NH) group. A broad band at 3550 cm^{-1} was seen for OH stretching. Bands at 1595, 1560 (C===C), 1440, 1380 for C--N and 760 cm^{-1} for the disubstituted benzene. NMR spectrum of this compound displayed a multiplet at δ 6.7-7.2 for 18 protons. A broad singlet for 2H appearing at δ 4.5 was ascribable for the benzylic protons. Another broad singlet at δ 6.5 for 2H disappeared on D_2O shake, was ascribable for phenolic protons.

Reaction of 2-Nitrophenylbenzalaniline(VII) with Zinc Dust and Alcoholic Chloroform.

A similar treatment of the Schiff's base (XIII) with zinc dust and chloroform afforded a compound melting at 174°.



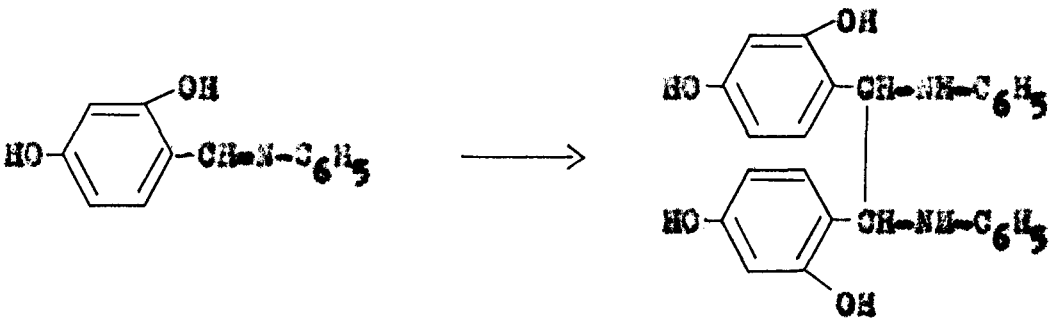
(VII) (XLIX)

Characterisation of the Compound m.p. 174° as 1,2-di-(2-nitrophenyl)-1,2-diaminophenylethane(XLIX)

The compound melting at 174° gave correct analysis for $C_{26}H_{22}N_4O_4$. UV absorption maximum was observed at 280 nm. IR spectrum of this compound gave absorption peaks at 3180-3120, for NH, 3015 (C=C—H), 1610, 1580 cm^{-1} for benzene ring streching (C═══C). Bands at 1530, 1370 were assigned for aromatic nitro groups streching, and bands at 1340 and 700 cm^{-1} are compatible with (C-N) and disubstituted benzene respectively. NMR spectrum of this compound gave a multiplet at δ7.3-7.8 for 18 aromatic protons. A doublet like signal for 2 protons at δ4.82 can be assigned to the benzylic protons.

Reaction of 2,4-Dihydroxybenzalaniline(VIII) with Zinc Dust and Ethanolic Chloroform

Reaction of imine (VIII) with the above reagent was carried out under similar conditions. After usual work-up and crystallisation a compound m.p. 160° was secured.



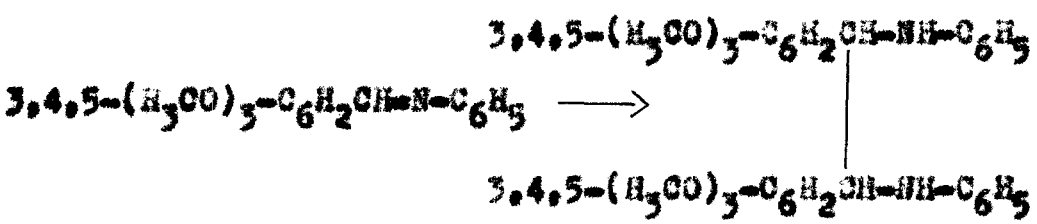
(VIII) (L)

Characterisation of the compound m.p. 160° as 1,2-di-(2,4-dihydroxyphenyl)-1,2-di-aminophenylethane(L)

Elemental analysis and molecular weight determination of (L) suggested the molecular formula as $C_{26}H_{24}N_2O_4$. UV absorption maximum was seen at 235 nm. IR spectrum of this compound showed bands at 3655, 3220, and 3180 corresponding to OH and NH functions. Bands at 3030, 1590, 1560 and 1440 cm^{-1} are compatible with (C=C--H, C═══C) and (C-H) stretching frequencies respectively. A band at 830 cm^{-1} is the characteristic for the trisubstituted benzene. NMR spectrum lends further support to this structure. A multiplet for 16 protons appearing between δ 6.6-7.1 was assigned for aromatic protons. A singlet for 2 protons at δ 4.45 was assigned to benzylic protons. A broad singlet observed at δ6.5 exchangeable with D_2O is compatible for 4 protons of the phenolic system.

Reaction of 3,4,5-Trimethoxybenzalaniline(IX) with Zinc Dust and Chloroform

The compound (IX) was reduced with zinc dust and chloroform in the usual manner, yielding a compound melting at 210°.



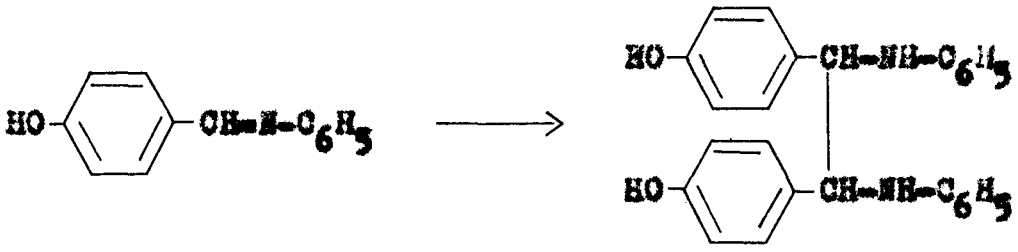
(IX) (LI)

Characterisation of the Compound m.p. 210° as 1,2-di-trimethoxyphenyl)-1,2-diaminophenylethane(LI)

The compound m.p. 210° gave correct analysis for $C_{32}H_{36}N_2O_6$. UV absorption maximum appearing at 285 nm. IR spectrum exhibited bands at 3260 – 3220 cm^{-1} for NH group. Bands at 3015, 1600 1575 and 1480 cm^{-1} were seen for C=C—H, C=====C, and C—N functions. NMR of this compound exhibited a multiplet at δ 6.4-7.2 for 16 aromatic protons. A broad singlet appeared at δ 4.75 for two benzylic protons. Another broad singlet was found at δ 5.2 for 2 amino protons. (D_2O exchangeable). A singlet for 18 protons at δ 3.55 was assigned for 6 methoxy group on two aromatic rings.

Reaction of 4-Hydroxybenzalaniline(X) with Zinc Dust and Ethanolic Chloroform

Compound (X) was subjected to reduction with the above reagent in the usual way. Subsequent work-up of the reaction mixture afforded a compound melting at 194°.



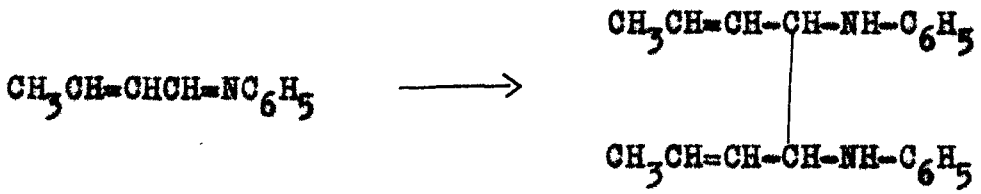
(X) (LII)

Characterisation of the compound m.p. 194° as 1,2-di-(4-hydroxyphenyl)-1,2-diaminophenylethane(LII)

Compound melting at 194° was analysed for $C_{26}H_{24}N_2O_2$. UV absorption maximum was observed at 295 nm. IR absorption bands showed at 3530 and 3240 - 3210 for OH and NH groups respectively. Bands at 3020, 1610, 1575 cm^{-1} were observed for (C=C--H) and (C=== C) stretchings and a band at 750 cm^{-1} was observed for disubstituted benzene. The NMR spectrum of this compound exhibited a multiplet for 18 protons at δ 6.9-7.3, assigned to aromatic protons. A broad singlet at δ 4.7 for two protons of benzylic group suggested the formation of the bimolecular product (LII).

Reaction of Zinc Dust and Chloroform with Crotonalaniline(XI)

Reaction of substrate (XI) in a similar fashion furnished a product m.p. 168-70°.



(XI) (LIII)

Characterisation of the compound m.p. 168-70° as 1,2-di-protonà-1,2-diaminophenylethane(LIII)

Compound m.p. 168-70° was analysed for $C_{20}H_{24}N_2$. It gave UV absorption maximum at 252 nm. IR spectrum of this compound showed bands at 3310-3280 for NH and 2870 cm^{-1} for saturated C—H streching. A band at 3010 cm^{-1} suggested the presence of (C=C—H) grouping. Bands at 1610, 1585 for (C=C) and 760 cm^{-1} are also for benzene ring. The NMR spectrum proved helpful in the assignment of its structure as (LIII). It showed a doublet at δ1.75 for 6 protons of two methyl groups attached to the allylic carbon atoms. A multiplet at δ5.8 was assigned to the vinylic protons, whereas a distorted doublet which appeared at δ6.4 was due to vinylic protons. A multiplet for 10 protons centred at δ7.1 was assigned to aromatic protons. A broad doublet like signal at δ5.9 (D_2O exchangeable) for 2 amino protons was also observed.

Reaction of Butyralaniline(XII) with Zinc Dust and Chloroform-Ethanol Mixture

Reaction of (XII) with the reagent was effected in a similar manner. Usual work-up and crystallisation provided a compound, m.p. 142°.

$CH_3CH_2CH_2CH{=}NC_6H_5$ ⟶ $CH_3CH_2CH_2CH(-NH-C_6H_5)-CH(-NH-C_6H_5)CH_2CH_2CH_3$

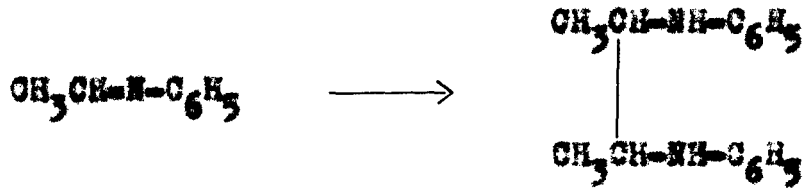
(XII) (LIV)

Characterisation of the Compound m.p. 142° as 1,2-dipropane-1,2-diaminophenylethane(LIV)

Molecular weight determination and elemental analysis of the compound m.p. 142° gave the molecular formula as $C_{20}H_{28}N_2$. The UV absorption maximum of this compound was observed at 235 nm. IR spectrum of this compound exhibited absorption bands at 3210—3150 for NH group, 3025, 1600, 1575 cm^{-1} for the (C=C—H) and (C=====C) stretchings. NMR spectrum of this compound exhibited a triplet at δ3.20 for two protons on the carbon attached directly to nitrogen atom. Methyl group protons (6H) appeared as a triplet at δ1.02. A multiplet for 8 protons of methylene protons was centred at δ1.4. Another multiplet at δ 6.9-7.2 was assigned for 10 aromatic protons.

Reaction of Acetalaniline (XIII) with Zinc Dust and Chloroform

Reduction of compound (XIII) with the above reagent was performed in a similar fashion. Usual work-up and crystallisation of the reaction mixture yielded a compound melting at 174°.



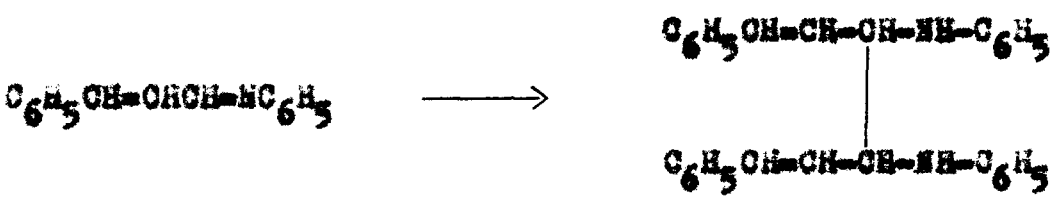
(XIII) (LV)

Characterisation of the Compound m.p. 174° as 1,2-dimethyl-1,2-diaminophenylethane(LV)

Compound melting at 174° was correctly analysed for $C_{16}H_{20}N_2$,(Molecular weight of this compound was found to be 240) and UV absorption maximum observed at 220 nm. IR spectrum displayed absorption bands at 3310-3500 cm^{-1} for (NH) group. Bands at 3010 and 1600 - 1560 cm^{-1} were observed for (C=C—H) and (C=—=C) respectively. A band at 2960 cm^{-1} is due to the saturated C—H strechings, and bands at 780, 750 cm^{-1} are seen for monosubstituted benzene. The NMR spectrum of this compound showed a quartet like signal at δ3.0 for 2 protons attached to the aniline groups. A doublet at δ1.15 for 6 protons of methyl group was also observed. A multiplet at δ6.8-7.22 was seen for 10 aromatic protons. Amino protons seen at δ 4.9 were found to be exchangeable with D_2O.

Reaction of Cinnamalaniline (XIV) with Zinc Dust and Chloroform

The substrate (XIV) when heated with zinc dust and alcoholic chloroform in the usual way yielded a compound m.p. 155°.



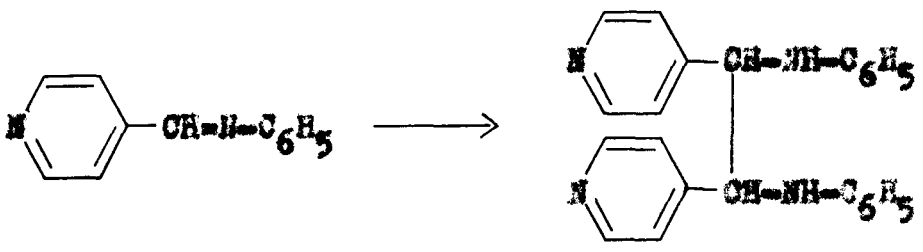
(XIV) (LVI)

Characterisation of the Compound m.p. 155° as 1,2-dicinnamyl-1,2-diaminophenylethane(LVI)

The compound, m.p. 155° gave correct analysis for $C_{30}H_{28}N_2$. UV absorption maximum of this compound was observed at 285 nm. IR spectrum of (LVI) gave absorption bands at 3150-3120 (NH), 3030 (C=C—H), 1605, 1550 (C=C), 1620 (C=C) and 760 cm^{-1} for mono-substituted benzene. NMR spectrum of this compound showed a multiplet for 20 protons between δ 6.7-7.8 assigned to aromatic protons. The vinylic protons (2H) attached to the benzene ring was observed at δ6.5 as a doublet. A triplet at δ6.2 was assigned to the vinylic protons attached to the allylic carbon atom. Another distorted doublet at δ4.90 was assigned to the two allylic protons on the carbon atom adjacent to nitrogen. The foregoing discussion led to the assignment of the structure (LVI) for the compound having m.p. 155°.

Reaction of Pyridal-4-Aniline(XV) with Zinc Dust and Ethanolic Chloroform

Reaction of (XV) with the above reagent in the usual manner gave a compound melting at 145°.



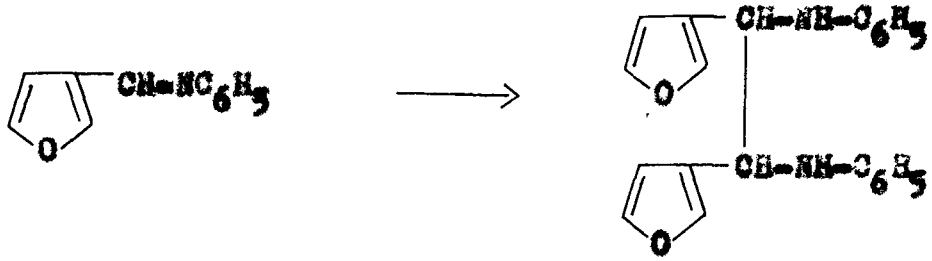
(XV) (LVIII)

Characterisation of the Compound m.p. 145° as 1,2-dipyridyl-1,2-diaminophenylethane(LVII)

The compound m.p. 145° was analysed for $C_{24}H_{22}N_4$. UV absorption maximum appearing at 238 nm indicated the presence of aromatic rings. IR spectrum displayed a broad absorption band at 3200 cm^{-1} for NH group. Bands at 3020, 1600, 1580 cm^{-1} were observed for (C=C—H), (C===C) of the benzene ring. Bands observed at 1420 and 1380 cm^{-1} were seen for (C—N) group. The NMR spectrum showed a multiplet at δ 8.90 for four protons of the two pyridine ring. Another multiplet at δ 7.1-7.5 was observed for 14 protons, where 4 protons of the pyridine ring were also merged with aromatic protons. A doublet like signal for 2 protons at δ 5.8 was assigned to pyridylic protons.

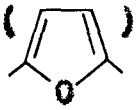
Reaction of Furfuralaniline (XVI) with Chloroform and Zinc Dust

Treatment of imine (XVI) with zinc dust and chloroform ethanol mixture in a similar way afforded a compound m.p. 182°.



(XVI) (LVIII)

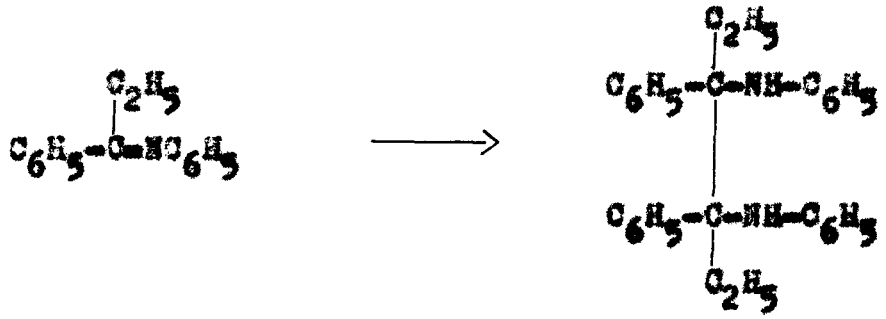
Characterisation of the compound m.p. 182° as 1,2-difurfural-1,2-diaminophenylethane(XVIII)

Elemental analysis and molecular weight determination for $C_{22}H_{20}N_2O_2$ was observed for the compound m.p. 182°. UV spectrum of this compound exhibited absorption maximum at 265 nm. IR spectra of this product displayed absorption bands at 3210 (NH), 3025, 1595, 1550 for (C=C—H, C=—C) and 1630 cm^{-1} characteristic for furan (C=C—O) group, and 750 cm^{-1} for monosubstituted benzene . NMR spectrum showed a multiplet at δ 6.5-7.3 assigned to 10 aromatic protons. A distorted doublet at δ 7.5 appeared for 4 protons ()

A doublet was seen for 2 protons allylic to the furan ring at δ 4.25 (). A triplet like signal at δ 6.2 was seen for another two protons of the furan ring () and a multiplet for 4 protons observed at δ 7.34 is ascribable for furan ring protons.

Reaction of 1-Ethyl-1-benzalaniline (XXII) with Zinc Dust and Ethanolic Chloroform

Reaction of (XVII) with zinc dust and chloroform was performed in the same manner. Usual work-up of the reaction mixture afforded a compound, m.p. 184°.



(XVII) (LIX)

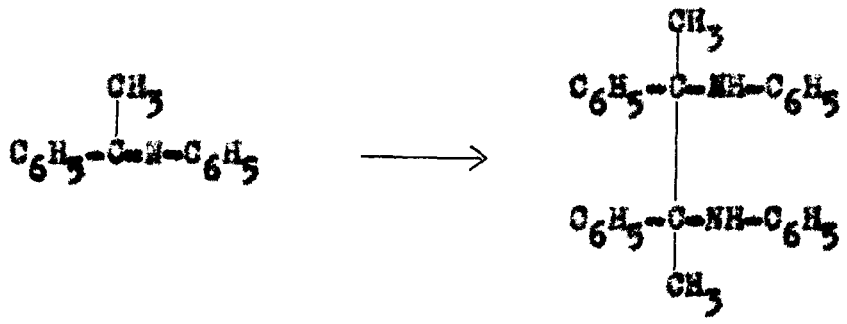
Characterisation of the Compound m.p. 184° as 1,2-diphenyl-diethyl-1,2-diaminophenylethane(LIX)

Elemental analysis and molecular weight determination of the compound m.p. 184° gave $C_{30}H_{32}N_2$ as its molecular formula. IR spectrum of this product showed characteristic bands at 3200 for NH, 3030, 2960, 1600, 1585 for (C=C—H, Saturated C—H, C——C) and 780, 745 cm^{-1} (mono-substituted benzenes). The NMR spectrum helped in the assignment of its structure, as (LIX). A multiplet for 20 protons observed at δ 6.9-7.3 was due to the aromatic hydrogens. A 4 protons quartet seen at δ 1.8 was ascribable for methylene group protons whereas a triplet appeared at δ 1.3 for 6 protons of methyl group ($-CH_2$ $-CH_3$ -x 2). Amino protons were seen as a broad singlet at δ 8.9 (exchangeable with D_2O).

Reaction of Zinc Dust and Chloroform-Ethanol Mixture with 1-Methyl-1-benzalaniline(XVIII)

A mixture of Schiff base (XVIII), zinc dust and ethanol chloroform mixture was refluxed on a steam bath. Subsequent

work-up and removal of the solvent yielded a product, m.p. 167°.



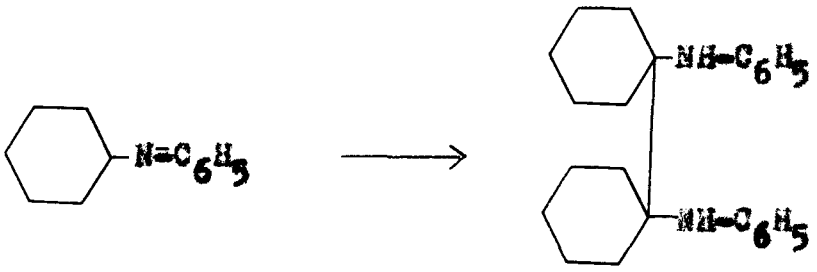
(XVIII) (LX)

Characterisation of the compound m.p. 167° as 1,2-diphenyl-dimethyl-1,2-diaminophenylethane(LX)

The compound m.p. 167° gave elemental analysis for $C_{28}H_{28}N_2$. IR spectrum exhibited bands at 3310, 3015, 2980 and 1610, 1540 cm^{-1} corresponding to NH, C=C—H, C—H and C===C streching respectively. The NMR spectrum displayed a multiplet at δ 6.9-7.3 for 20 aromatic protons. A sharp singlet for 6 protons of two methyl group appeared at δ 1.52. These studies confirmed the structure of compound m.p. 167° as (LX).

Reaction of cyclohexalaniline (XIX) with Zinc Dust and Chloroform

Treatment of compound (XIX) with the above reagent under similar conditions was effected. Subsequent work-up and crystallisation furnished a compound melting at 180°.



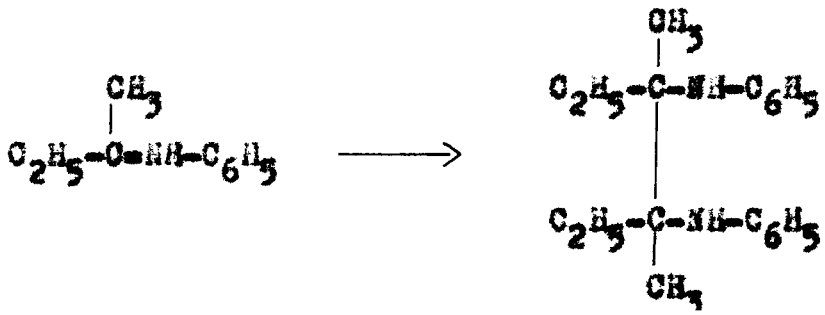
(XIX) (LXI)

Characterisation of the Compound m.p. 180° as 1,2-dicyclohexane-1,2-diaminophenylethane(LXI)

The compound, m.p. 180° gave analysis for $C_{24}H_{34}N_2$, (UV absorption maximum appeared at 245 nm). IR spectrum showing bands at 3220-3180, 3020, 2980 and 1580 cm^{-1} suggested the formation of bimolecular product (LXI). The NMR spectrum of this compound displayed a distorted doublet at δ8.4 for 2 amino protons, diminished on D_2O shake. A multiplet at δ7.3-7.55 was ascribed for 10 aromatic protons. Another multiplet at δ0.8-1.2 was due to 20 protons of cyclohexane system.

Reaction of Isobutalaniline(XX) with Zinc Dust and Chloroform

Treatment of compound (XX) with zinc dust and chloroform ethanol mixture, gave a compound melting at 160°.

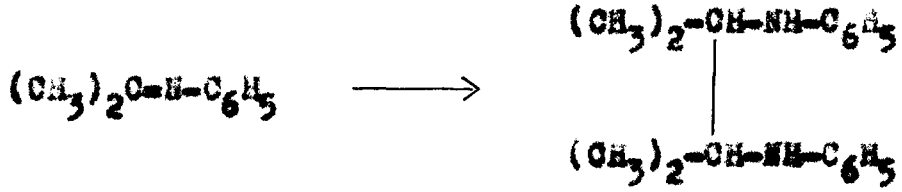


Characterisation of the compound m.p. 160° as 1,2-diethyl-dimethyl-1,2-diaminophenylethane(LXII).

The compound, m.p. 160°, gave correct elemental analysis for $C_{20}H_{28}N_2$. IR spectrum exhibited band at 3325, 3020, 1595, 1570 cm^{-1} for NH, aromatic ring. A band at 2960-80 cm^{-1} indicated the presence of saturated alkyl group (C—H strechings). NMR spectrum lend support to the structure (LXII) by exhibiting a singlet for 6 protons of two methyl groups which appeared at δ1.5. Another triplet for 6 protons of two methyl groups (CH_3-CH_2) of the ethyl substituents appeared at δ1.2 and a quartet for 4 protons appeared for methylene (CH_3-CH_2) protons at δ1.7 . A multiplet at δ 6.9-7.7 for 10 protons was observed for aromatic protons.

Reaction of Isopropalaniline(XXI) with Zinc Dust and Ethanolic Chloroform

Treatment of compound (XXI) with the above reagent was carried out in the usual manner. A compound melting at 175° was secured after usual work-up of the reaction mixture.



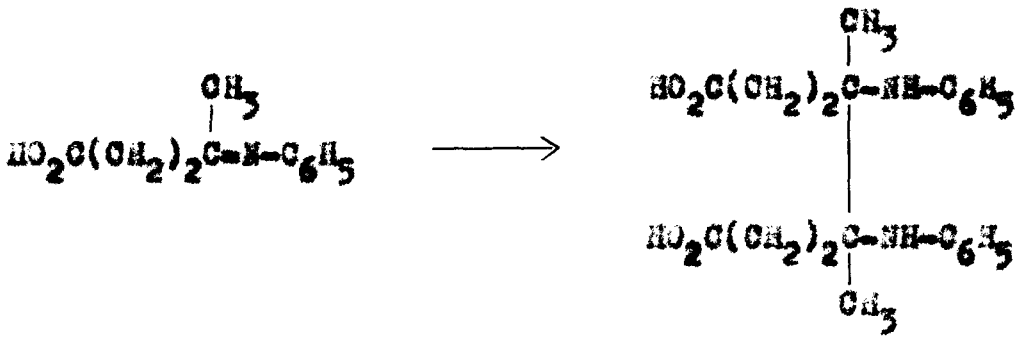
(XXI) (LXIII)

Characterisation of the compound m.p. 175° as 1,2-dimethyl-1,2-diaminophenylethane(LXIII)

The above compound gave analysis for $C_{18}H_{24}N_2$. IR spectrum of this compound showed absorption band corresponding to NH and phenyl ring at 3220, 3025, 2960 (C=C—H, C—H), 1585, 1550 (C=—=C), 1490 cm^{-1} for C—N streching. NMR of this compound gave a multiplet at δ 6.8-7.25 for 10 aromatic protons. A singlet for 12 methyl protons appeared at δ 1.05. Amino protons seen as a broad signal at δ 8.5 were found to be exchangeable with D_2O.

Reaction of 1-Methyl-3-carboxylicpropanaliline(XXII) with Zinc Dust and Ethanolic Chloroform

A similar reaction of (XXII) with zinc dust and chloroform provided a compound melting at 135°.



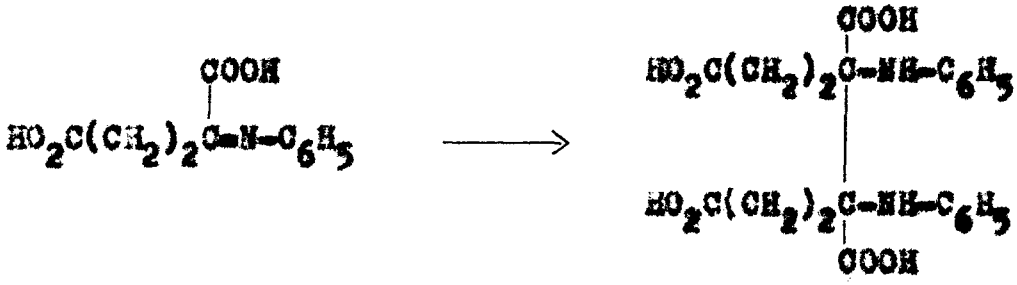
(XXII) (LXIV)

Characterisation of the Compound m.p. 135° as 1,2-dimethyl-(1,2-dicarboxyethane)-1,2-diaminophenylethane(LXIV)

The compound, m.p. 135°, confirmed analysis for $C_{22}H_{28}N_2O_4$. IR spectrum of this compound gave absorption bands at 3250, 2680, 2560 and 1720 cm^{-1} for NH and COOH functions. A band at 2980 cm^{-1} was seen for saturated C—H streching frequencies. Bands at 3015, 1595 cm^{-1} were compatible with the aromatic system. The NMR spectrum of this compound gave a singlet at δ1.15 for 6 protons which can be assigned to a pair of methyl groups. A multiplet at δ 2.0-2.8 integrating for 8 protons is ascribable for the methylene protons adjacent to carboxylic acid. A broad hump like signal for 2 protons at δ11.5 was due to the two protons of the carboxylic group. Another multiplet at δ 7.52 was ascribed for 10 aromatic protons Two amine protons observed at δ 6.2 were found to be diminished on D_2O shake.

Reaction of 1,3-Dicarboxylicpropananiline(XXIII) with Zinc Dust and Chloroform

Reaction of (XXIII) with the above reagent and usual work-up of the reaction mixture provided a compound, m.p. 183°.



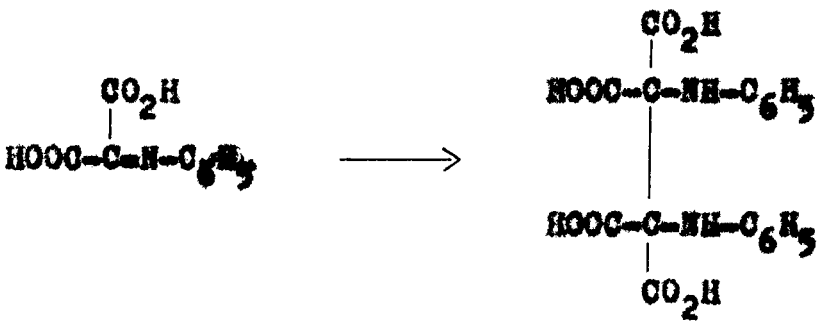
(XXIII) (LXV)

Characterisation of the Compound m.p. 183° as 1,2-dicarboxy (1,2-dicarboxyethane)-1,2-diaminophenylethane(LXV)

Compound, m.p. 183°, was analysed for $C_{20}H_{20}N_2O_8$. IR spectrum of this compound showing bands at 3220-3180, 3010, 2680-2530, 1595, 1520, 1360 and 1380 cm^{-1} corresponds to NH, C=C--H, C=C, COOH and C--N functions. A strong band at 1720-1715 cm^{-1} characterises for the keto group of the carboxylic system. NMR spectrum showed a multiplet centred at δ 1.85 for 8 protons of a pair of methylene group. A multiplet at δ 6.9-7.55 for 10 aromatic protons was seen. A broad hump like signal observed at δ 10.85 for the carboxylic protons exchangeable with D_2O.

Reaction of 1,1-Dicarboxylic methylaniline(XXIV) with Zinc Dust and Chloroform

Schiff base (XXIV) was subjected to reduction with zinc dust in chloroform ethanol mixture. The usual work-up of the reaction mixture followed by crystallisation furnished a compound, m.p. 178°.



(XXIV) (LXVI)

Characterisation of the Compound m.p. 178° as 1,2-Tetra-carboxy-1,2-diaminophenylethane(LXVI)

The compound, m.p. 178°, gave elemental analysis for $C_{18}H_{16}N_2O_8$. UV spectrum exhibited absorption maximum at 238 nm. IR absorption bands appearing at 3180-3015, 2855, 2635, 1580, 1720, 1430, cm^{-1} corresponds to NH, C=C—H, C=C, C—N and COOH functions. In NMR spectrum of this compound, a multiplet centred at δ 7.55 is ascribable for 10 aromatic protons. A doublet at δ 6.56 due to 2 amine protons (D_2O exchangeable) and broad humps at δ 11.7 and δ 10.95 for 4 carboxylic protons were also found to be exchangeable on addition of D_2O.

Reaction of phenylhydrazones with zinc dust and chloroform : Formation of bimolecular reduction products

During the past two decades many variations in the design of compounds on the theme of structural activity has led to the synthesis and testing of thousands of compounds. Among various attempts to prepare compounds with greater specificity of actions, the concept of latent activity has attracted a number of investigators. In order to explore this possibility, our growing interest in this area has led to the synthesis of bimolecular products of phenylhydrazones.

Keeping in view, the innumerable biological properties of nitrogenous compounds, we, in addition to the synthesis of bimolecular or reductive dimerised products of Schiff's bases (XLIII-LXVI) extended our studies to the bimolecular reduction of phenylhydrazones in order to study the effect of nitrogen insertion into the azomethine system aiming at increasing the potentialities of their drug effect having enhanced number of nitrogens.

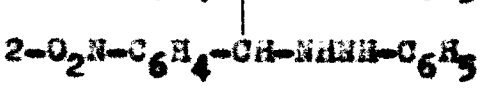
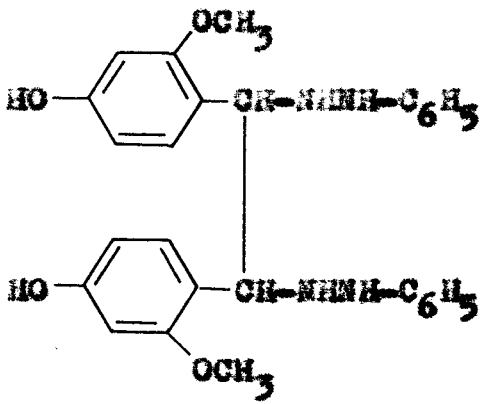
The reaction of phenylhydrazones (XXV-XLII) with zinc dust in presence of ethanolic chloroform, was carried out in a way similar to that of Schiff's bases. Analogous to that of the previous results, we obtained the reductive dimerised products of phenylhydrazones (LXVII-LXXXIV) in excellent yields. The details of their physical constants and spectral values for their structural elucidations have been discussed in the following table.

Bimolecular Reduction Products of Phenylhydrazones

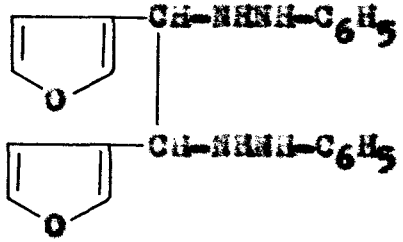
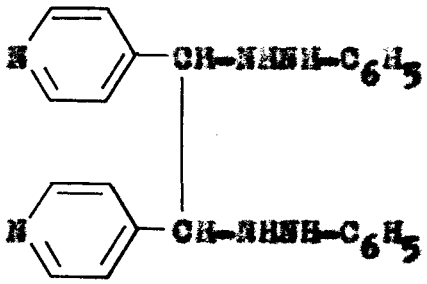
S.No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max.nm	IR(KBr/Nujol) ν max. cm^{-1}	NMR ($DMSOd_6/CDCl_3$) δ, ppm
25.	$C_6H_5CH(C_6H_5CH(NHNH{-}C_6H_5)-NHNH-C_6H_5)$ 1,2-Diphenyl-1,2-dihydrazo-phenylethane (LXVII)	140	345	3240-3148(NH), 3010 (C=C-H); 1600,1565 (C=C); 1450 (C-H) 740(mono-substituted benzene)	6.8-7.3(m,20H,arom.) 5.8(dist. d, 2H, anilino protons, D_2O exchangeable) 4.9(br. s, 2H, benzylic)
26.	$4\text{-}NO_2\text{-}C_6H_4\text{-}CH(4\text{-}NO_2\text{-}C_6H_4\text{-}CH(NHNH{-}C_6H_5)\text{-}NHNH\text{-}C_6H_5$ 1,2-Bis-(4-nitrophenyl)-1,2-dihydrazophenylethane (LXVIII)	130	285	3255-3180(NH), 3025 (C=C-H); 2055(N-H); 1600,1580,1555(C=C) 1380(C-H); 780,720 (mono and di-substi-tuted benzene)	7.2-7.5(m,18H,arom.) 5.7(d, 2H, NH-Ph) 4.9 (t,2H,O_2N-Ph-CH-NH) 5.2(t,2H,benzylic)

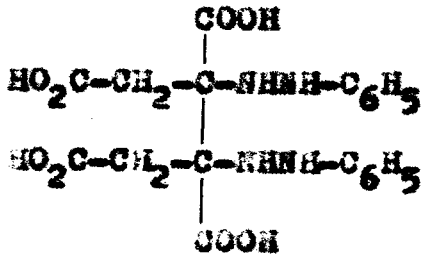
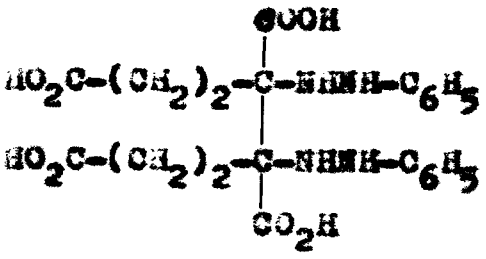
S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ_{max}, nm	IR(KBr/Nujol) ν max, cm^{-1}	NMR($DMSO-d_6$/$CDCl_3$) δ, ppm
27.	$(H_3C)_2$-N.C_6H_4CH-NHNH-C_6H_5 $(H_3C)_2$-N.C_6H_4CH-NHNH-C_6H_5 1,2-Di-(4-dimethylaminophenyl)-1,2-dihydrazophenylethane(LXIX)	118	320	3245-3185(NH),3015,2805O (w)(benzene and C-H stretching);1600,1580, 1420,1360(C=C,C-N);750, 720(mono-substituted benzene)	6.5-7.2(m,20H,aromatic); 5.6(S,2H,benzylic) 4.1 [12H,S, -N$(CH_3)_2$]
28.	2-OH-C_6H_4-CH-NHNH-C_6H_5 2-OH-C_6H_4-CH-NHNH-C_6H_5 1,2-Di-(2-hydroxyphenyl)-1,2-dihydrazophenylethane(LXX)	125	280	3555(OH);3230-3185(NH) 3020,1640,1575,1555 (C=C-H,C=C) 1455,1245 (C-N,C-O);780,720(mono-substituted benzene)	3.85(br,S,2H,OH-Ph); 6.5-7.3(m,18H,aromatic proton);4.50(S,2H, benzylic protons)

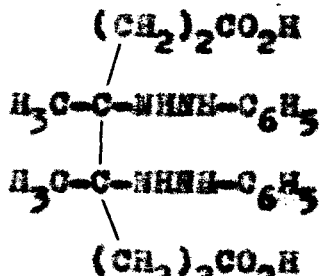
S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR(KBr/Nujol) ν max, cm^{-1}	NMR ($DMSO-d_6$/$CDCl_3$) δ ppm
29.	4-HO-C_6H_4-CH-NHNH-C_6H_5 4-HO-C_6H_4-CH-NHNH-C_6H_5 1,2-Di-(4-hydroxyphenyl)-1,2-dihydrazophenylethane(LXXI)	188	285	3545(OH), 3220-3170(NH); 3020, 1620, 1580, 1460, 1390 (C=C-H, C=C, C-N); 785, 720 (mono-substituted benzenes)	8.5(2H, br. s, OH-Ph) 6.8-7.7(m, 18H, aromatic) 4.4(s, 2H, benzylic)
30.	3,4-(H_3CO)$_2$-C_6H_3-CH-NHNH-C_6H_5 3,4-(H_3CO)$_2$-C_6H_3-CH-NHNH-C_6H_5 1,2-Di-(3,4-dimethoxyphenyl)-1,2-dihydrazophenylethane(LXXII)	105	295	3210-3145(NH) 3030, 1620, 1575, 1390, 1020, (C=C-H, C=C, C-O)	6.8-7.22(m, 16H, aromatic) 4.85(s, 2H, benzylic); 3.2(s, 12H, 2x MeO-Ph)

S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR (KBr/Nujol) ν max, cm^{-1}	NMR ($DMSO-d_6/CDCl_3$) δ ppm
31.	 1,2-Di-(2-nitrophenyl)-1,2-dihydrazophenylethane (LXXIII)	143	325	3245-3180(NH) 3015, (C=C-H, N-H); 1640, 1575, 1360, 1320(C=C, C-N); 785, 735(mono-substituted benzenes)	8.5(2H, NH-Ph, D_2O exchangeable); 7.2-7.6 (m, 18H, aromatic); 6.3 (d, 2H, benzylic protons)
32.	 1,2-Di-(4-hydroxy-3-methoxyphenyl)-1,2-dihydrazophenylethane (LXXIV)	173	332	3665(O-H) 3210-3160 (NH), 3030, 2040(w) (C=C-H, N-N), 1575, 1490, 1320(C=C, C-N), 820	9.8(dist. d, 2H-OH-Ph) 7.2(m, 10H, aromatic protons) 4.2(br. s, 2H, benzylic) 3.5(s, 6H, 2xOMe-Ph, $C_{1,2}$)

S. No.	Binolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR(KBr/Nujol) ν max, cm^{-1}	NMR ($DMSO-d_6/CDCl_3$) δ ppm
33.	$C_6H_5CH=CH-CH(CH=CH-CH=NHNH-C_6H_5)-NHNH-C_6H_5$ 1,2-Dicinnamal-1,2-di-hydrazophenylethane(LXXV)	155-56	315	3240,3180(NH),3010 (C=C-H)2035(w) (N-N); 1655, 1645, 1600, 1420, 1390(C=C,C-N,-C=C-); 780 (Substituted benzene)	6.9-7.5(m,20H,aromatic) 6.1 (d,2H,benzylidene protons) 5.9 (t,2H, vinylic protons) 3.82 (d,2H,allylic protons)
34.	$H_3CO-C_6H_4-CH(NHNH-C_6H_5)-CH(C_6H_4-OCH_3)-NHNH-C_6H_5$ 1,2-Di-(4-methoxyphenyl)-1,2-dihydrazophenylethane(LXXVI)	115	380	3275-3130(NH); 3030 (C=C-H, aromatic); 1585, 1620,1440,1355 (C=C,C-N)	6.5-7.32(m,18H,aromatic protons) 3.9 (6H,s,$H_3CO-Ph-C_{1,2}$) 4.18 (br, s, 2H, benzylic protons)

S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR(KBr/Nujol) ν max, cm^{-1}	NMR (DMSOd_6/CDCl$_3$) δ ppm
35.	 1,2-Difurfural-1,2-dihydrazo-phenylethane(LXXVII)	169-70	329	3220-3180(NH),3025, (aromatic system) 1590, 1640,1435,1320,1280 (C=C,C-N).	6.8-7.45(m,10H,aromatic protons) 4.38 (br. s, 2H, 2x )
36.	 1,2-Dipyridyl-1,2-dihydrazo-phenylethane(LXXVIII)	184-85	275	3280-3200(NH). 3020, 1635,1575,1545 (C=C-H, C=C), 1425, 1340 (C-N stretching)	7.1-7.5 (m,18H,aromatic) 4.75(d,2H, ); 4.10(d,4H,2x )

S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR(KBr/Nujol) ν max, cm^{-1}	NMR ($DMSO-d_6/CDCl_3$) δ ppm
37.	 1,2-Dicarboxymethane-1,2-dicarboxy-1,2-dihydrazophenylethane(LXXIX)	186-87	332	3220-3145,3015(NH, C=C-H)aromatic system) 2620-2580,2920,1730 (COOH,C-H streching) 1650,1585,1470,1390 (C=C,C-N)	11.5 (2H,br. S,-CH_2COOH) 10.3 (br. S,2H,CO_2H-$C_{1,2}$) 6.9-7.4(m,10H,aromatic) 2.8 (4H, S,CH_2-COOH)
38.	 1,2-Dicarboxyethane-1,2-dicarboxy-1,2-dihydrazophenylethane(LXXX)	180	335	3220,3165(NH), 3025 2080 (C=C-H,N-H) 2585-2635(COOH) 1730 (COOH), 1620,1575,1445 (C=C, C-N)	10.8(br. S,2H, $(CH_2)_2$ COOH), 9.5 (br. S, 2H, COOH,$C_{1,2}$ diminished on D_2O shake) 7.1-7.5 (m,aromatic protons)

S. No.	Bimolecular Products	M.P. °C	UV (EtOH,95%) λ_{max},nm	IR(KBr/Nujol) ν_{max}, cm^{-1}	NMR ($DMSO-d_6/CDCl_3$) δ ppm
39.	 1,2-Dimethyl-1,2-dicarboxyethane-1,2-dihydrazophenylethane(LXXXI)	152	320	3225-3145(NH),3015 (benzene ring streching) 2595-2620,1720 (COOH,C-H) 1645,1575, 1445,1360 (C=C,C-H)	8.85 br,S,2H $(CH_2)_2CO_2H$ D_2O exchangeable) 7.2-7.35 (m,10H,aromatic) 2.9 (t,4H,CH_2COOH) 1.15 (S,6H,CH_3-$C_{1,2}$) 1.3 and 1.52 (t,4H,2x$(CH_2)_2$COOH
40.	 1,2-Dicarboxy-1,2-dihydrazo-phenylethane(LXXXII)	210	245	3245-3195(NH),2810, 2690,1735,1575,1340, 1295 (C=C,C-N,C-O, COOH)	11.55 (br,S,2H,CO_2H-$C_{1,2}$) 7.1-7.3 (10H,m,aromatic protons) 3.6 (d,2H, HO_2C-CH-NH)

S. No.	Bimolecular Products	M.P. °C	UV (EtOH, 95%) λ max, nm	IR (KBr/Nujol) ν max, cm^{-1}	NMR (DMSOd_6/CDCl$_3$) δ ppm
41.	$HO_2C-C_6H_4-CH-NHNH-C_6H_5$ $HO_2C-C_6H_4-CH-NHNH-C_6H_5$ 1,2-Dicarboxyphenyl-1,2-dihydrazophenylethane(LXXXIII)	205	255	3210-3185(NH) 3015 (C=C-H), 2590-2635, (-COOH), 1730(-COOH) 1610,1585 (C=C) 1440, 1395 (C-N)	9.58 (br.S,2H,HO_2C-Ph) 7.55 (m,18H,aromatic protons) 4.9 (S,2H, benzylic protons)
42.	$H_3C-C(CH_3)-NHNH-C_6H_5$ $H_3C-C(CH_3)-NHNH-C_6H_5$ 1,2-Dimethyl-1,2-dihydrazo-phenylethane(LXXXIV)	92-93	225	3310,3240(NH); 3030, 2710, 1440,1325 (C=C-H,C-H,C-N) 785 (mono-substituted benzene)	7.2-7.8 (m,10H,aromatic) 2.3 (S,6H,CH_3-C$_{1,2}$) 1.95 (S,6H,CH_3-C$_{1,2}$)

EXPERIMENTAL

Melting points reported in the thesis are in °C and are uncorrected. UV spectra were obtained with a Beckmann DK-2 spectrophotometer. IR spectra were determined in KBr/Nujol with a Perkin Elmer 621 spectrophotometer. NMR spectra were run on a varian A 60 instrument with Me_4Si as the internal standard. TLC plates were coated with silica gel G. Aqueous perchloric acid solution (20%) was used as spraying agent. Molecular weight determination was carried out using Beckmann's depressing in freezing point method. NMR values are given in δ ppm (S=singlet; d=doublet; t=triplet; br=broad; m=multiplet and q=quartet).

Synthesis of Imines or Schiff's bases

Schiff's bases of aldehydes, ketones and keto acids were obtained by treating these compounds with aniline in equimolar proportions in the presence of a small amount of glacial acetic acid, either at room temperature or by heating the reaction mixture under reflux on a steam bath. Schiff's bases were crystallised mostly by keeping the reaction mixture at room temperature or in a freezer. Crude products thus obtained was filtered, air dried and recrystallised from ethanol. Liquid Schiff's bases were extracted with ether, dried over anhydrous sodium sulphate and filtered. Solvent was removed under vacuo and imines were obtained as oily products.

Synthesis of Phenylhydrazones

Phenylhydrazones were prepared by the treatment of keto compounds with phenylhydrazine in the presence of small amount of glacial acetic acid. Most of the phenylhydrazones were obtained at room temperature, whereas in some cases the

reaction mixture was subjected to reflux temperature on a water bath for different periods of time yielding crude phenylhydrazones, these were filtered and recrystallized from ethanol.

1,2-Diphenyl-1,2-Diaminophenylethane(XLIII)

A solution of benzalaniline (3.62 g) in ethanol-chloroform mixture (20:1; 100 ml) was taken in a round bottomed flask and heated with zinc dust (1.5 g) under reflux for 4.5 hr on a steam bath. Progress of the reaction was checked through TLC. After the reduction was complete, the flask was removed and the contents filtered hot on a Buckner funnel. Zinc slurry was washed with hot mixture of ethanol-acetone (1:2, 2x15 ml). The combined filtrate and washings were evaporated under reduced pressure to 10 ml volume. The crystalline material secured on cooling was filtered and recrystallised from ethanol. Yield, 3.38 g, (93.5%); m.p. 130°.

UV : λ max (EtOH) 245 nm

IR : ν max (KBr) 3220-3145 (NH), 3020 (C=C——H, benzene ring), 1600, 1585 (C——C) 1450 (C-N) 740, 710 cm^{-1} (mono-substituted benzene).

NMR : δ ppm ($CDCl_3$) 7-7.25 (m, 20H, aromatic protons), 5.7 (d, 2H, NH-Ph, diminished on D_2O shake), 4.58 (br, s, 2H, benzylic protons).

Anal. for $C_{26}H_{24}N_2$ Calcd. C, 85.68; H, 6.64; N, 7.69;
Found C, 85.47; H, 6.55; N, 7.64%

1,2-Di-(4-dimethylaminophenyl)-1,2-diaminophenylethane(XLIV)

A solution of p-dimethylaminobensalaniline (2.72 g) in ethanol-chloroform mixture (20:1; 100 ml) was heated under reflux in a round bottom flask, with zinc dust (1.5 g) for 4 hr. A change of colour of the reaction mixture from dark to light yellow indicated the completion of reduction. Zinc slurry was filtered and washed with boiling ethanol. The combined filtrate and washings were concentrated under reduced pressure to 15 ml volume, and kept at room temperature. The crystalline product thus obtained was filtered and recrystallised from ethanol. Yield, 2.58 g (95%); m.p. 195°.

UV : λ max (EtOH) 232 nm

IR : ν max (KBr) 3240-3200 (NH); 3015 (C=C—H); 1575, 1540 (C=—=C) 1440, 1390 (C-N) and 730 cm^{-1} (disubstituted benzene).

NMR : δ ($CDCl_3$) 7.3-7.8 (m, 18H, aromatic protons); 5.7 (br. S, 2H-NH-Ph, D_2O exchangeable); 4.6 (br. S. 2H, benzylic); 3.25 ppm (6H, S, $H_3C-C_6H_4$x2).

Anal. for $C_{30}H_{34}N_4$ Calcd. C, 79.96; H, 7.61; N, 12.43
Found C, 79.87; H, 7.57; N, 12.38%

1,2-Di-(2-methoxyphenyl)-1,2-diaminophenylethane(XLV)

2-Methoxybenzalaniline (2.0 g) was dissolved in ethanol-chloroform mixture (20:1; 82 ml). To this zinc dust (1.5 g) was added. The mixture was heated under reflux for 5 hr to complete the reduction. The contents were then filtered hot and the zinc slurry washed with hot ethanol. Combined filtrate and washings were reduced under vacuo, when on cooling needle shaped crystals of (XLV) seperated. These were filtered, dried in air and recrystallized from methanol. Yield, 1.86 g (93%); m.p. 190°.

UV : λ max (EtOH) 255 nm

IR : ν max (KBr) 3240-3150 (NH); 3030 (C=C—H); 1585, 1560 (C=—=C); 1385 (C-N); 1250 cm^{-1} (C-O)

NMR : δ (DMSO-d_6) 7.1-7.6 (m, 18H, aromatic protons); 5.00 (br, S, 2H, 2xNH-Ph, D_2O exchangeable); 4.72 (br, S, 2H, benzylic); 3.5 ppm (S, 6H, 2xC_6H_4-OCH_3).

Anal. for $C_{28}H_{28}N_2O_2$ Calcd. C, 79.21; H, 6.65; N, 6.60

Found C, 79.15; H, 6.57; N, 6.55%

1,2-Di-(3-4-dimethoxyphenyl)-1,2-diaminophenylethane(XLVI)

3,4-Dimethoxybenzalaniline (2.25 g) zinc dust (2.0 g) and ethanol-chloroform mixture (20:1; 100 ml) was heated under reflux on a steam bath for 5.5 hr. The progress of the reaction was checked through TLC. Zinc slurry was removed through filtration. This was washed with two 15 ml portions

of boiling acetone-ethanol mixture (2:1). The filtrate and washings were combined and concentrated under diminished pressure to about 10 ml volume. On cooling crystalline product was obtained. This was recrystallised from aqueous ethanol (75%). Yield, 2.05 g (91.5%); m.p. 195°.

UV : λ max (EtOH) 238 nm

IR : ν max (Nujol) 3230-3180 (NH); 3010 (C=C—H); 1600, 1540 (C=C); 1380 (C-N); 880 cm^{-1} (Trisubstituted benzene).

NMR : δ ($CDCl_3$) 6.8-7.2 (m, 20H, aromatic protons); 5.9 (2H, d, NH-Phx2, diminished on D_2O shake); 4.70 (d, 2H, benzylic protons); 3.6 ppm (br. S, 12H, C_6H_4-OMe x 2).

Anal. for $C_{30}H_{32}N_2O_4$ Calcd. C, 74.35; H, 6.66; N, 5.78

Found C, 74.26; H, 6.59; N, 5.74%

1,2-Di-(4-nitrophenyl)-1,2-diaminophenyl ethane(XLVII)

To a solution of 4-nitrobensalaniline (2.26 g) in ethanol chloroform mixture (20:1; 100 ml), zinc dust (2.5 g) was added. This was refluxed for 5.5 hr and filtered. Zinc slurry was washed twice with acetone-ethanol mixture (2:1; 2 x 10 ml). The combined filtrate and washings were reduced under vacuo to a volume of 10 ml and cooled over night in a refrigerator, when crystalline product (XLVII) was obtained. This was filtered and recrystallised from ethanol. Yield, 1.88 g (84%); m.p. 160-61°.

UV : max (MeOH) 245 nm

IR : λ max (KBr) 3230-3210 (NH); 3020, 1600, 1590 (C=C—H, C═══C); 1370 (C-N) 750 cm^{-1} (di-substituted benzene).

NMR : δ ($CDCl_3$) 7.30-7.8 (m, 18H, aromatic protons); 4.86 ppm (br. S, 2H, benzylic protons).

Anal. for $C_{26}H_{22}N_4O_4$ Calcd. C, 69.71; H, 4.88; N, 12.33

Found C, 68.65; H, 4.77; N, 12.29%

1,2-Di-(2-hydroxyphenyl)-1,2-diaminophenylethane(XLVIII)

To a solution of 2-hydroxybenzalaniline (2.0 g) in chloroform-ethanol mixture (1:20; 82 ml) zinc dust (1.5 g) was added. This was heated on a steam bath for 6 hr and filtered. The zinc slurry was washed with hot ethanol (2x12 ml). The solvent was evaporated under reduced pressure, which on cooling afforded (XLVIII). This was recrystallised from absolute ethanol. Yield, 1.7 g (85%); m.p. 165°.

UV : λ max (EtOH) 252 nm

IR : ν max (Nujol) 3550 (OH); 3230-3150 (NH); 3010 (C=C—H); 1595, 1560 (C═══C); 1440, 1380 cm^{-1} (C-N)

NMR : δ ($CDCl_3$) 6.7-7.2 (m, 18H, aromatic protons); 6.5 (br. S, 2H, phenolic protons); 4.5 ppm (S, 2H, benzylic protons).

Anal. for $C_{26}H_{24}N_2O_2$ Calcd. C, 78.76; H, 6.10; N, 7.07

Found C, 78.59; H, 6.06; N, 7.03%

1,2-Di-(2-nitrophenyl)-1,2-diaminophenylethane(XLIX)

Treatment of 2-nitrobenzalaniline (2.26 g) with zinc dust (2.0 g) in ethanol-chloroform mixture (20:1; 100 ml) at

reflux temperature for 4.5 hr provided (XLIX). Crystallisation from ethanol-ethylacetate mixture (1:1) gave pure product. Yield 2.12 g (94%); m.p. 174°.

UV : λ max (Ethanol) 280 nm

IR : ν max (KBr) 3180, 3120 (NH); 3015, 1610, 1580 (C=C—H, C=C); 1420 (C-N) and 1355 cm^{-1} (NO_2).

NMR : δ ($CDCl_3$) 7.3-7.8 (19H, m, aromatic protons); 4.82 ppm (2H, s, 2xPh-CH).

Anal. for $C_{26}H_{22}N_4O_4$ Calcd. C, 68.71; H, 4.88; N, 12.33
Found C, 68.67; H, 4.82; N, 12.28%

1,2-Di-(2,4-dihydroxyphenyl)-1,2-diaminophenylethane(L)

2,4-Dihydroxybenzalaniline (2.13 g) was treated with zinc dust (1.5 g) in chloroform-ethanol mixture (1:20; 100 ml) on a water bath for 5 hr. The contents were filtered to remove zinc slurry and this was washed with ethanol (2x15 ml). The solvent was evaporated under vacuo to 15 ml volume and cooled. The crystalline material so secured was filtered, air dried and recrystallized from ethanol; Yield, 1.87 g (88%); m.p. 160°.

UV : λ max (MeOH) 235 nm

IR : ν max (KBr) 3655 (OH); 3220, 3180 (NH) 3030, 1590, 1560 (C=C—H, C=C); 1440 cm^{-1} (C-N).

NMR : δ (CCl_4+$DMSOd_6$) 6.6-7.1 (m, 16H, aromatic); 6.5 (br. s, 2H, hydroxy protons, D_2O exchangeable); 4.5 ppm (s, 2H, benzylic protons).

Anal. for $C_{26}H_{24}N_2O_2$ Calcd. C, 72.38; H, 5.65; N, 6.54
Found C, 72.73; H, 5.48; N, 6.49%

1,2-Bi(3,4,5-trimethoxyphenyl)-1,2-di-aminophenylethane(LI)

A mixture of 3,4,5-trimethoxybensalaniline (2.72 g), zinc dust (1.5 g) in ethanolic chloroform (100 ml; 20:1) was refluxed on a steam bath for 5 hr. The zinc slurry was then filtered and washed with hot ethanol. The combined filtrate and washings were evaporated under vacuo to afford (LI). This was recrystallized from methanol, Yield, 2.14 g; (79%); m.p. 210°.

UV : λ max (EtOH) 330 nm

IR : ν max (Nujol) 3260,3220 (NH) 3015, 1575 (C=C—H, C═══C); 1480 cm^{-1} (C-N).

NMR : δ (DMSOd_6) 6.7-7.2 (m, 16H, aromatic protons); 4.75 (2H, S, benzylic protons); 3.5 ppm (S, 18H, C_6H_4-OMe)

Anal. for $C_{32}H_{36}N_2O_6$ Calcd. C, 70.57; H, 6.66; N, 5.14
Found C, 70.51; H, 6.62; N, 5.09%

1,2-Bi-(4-hydroxyphenyl)-1,2-diaminophenylethane(LII)

A mixture of powdered 4-hydroxybenzalaniline (2.0 g) zinc dust (1.5 g) and ethanolic chloroform (20:1; 30 ml) was heated gently under reflux on a steam bath for 5 hr. The reaction mixture was then filtered hot and the zinc slurry was washed twice with hot ethanol (2x15 ml). The combined

filtrate and washing were evaporated under reduced pressure to a volume of 12 ml, when crystallization started. This was cooled and filtered. The crystalline product thus obtained was recrystallized from ethanol. Yield, 1.75 g (86.6%); m.p. 194°.

UV : λ max (EtOH) 295 nm

IR : ν max (KBr) 3530 (OH), 3240-3210 (NH) 3020, 1610, 1575 cm^{-1} (C=C—H, C=C).

NMR : δ ($DMSO-d_6$) 6.9-7.3 (m, 18H, aromatic protons); 5.85 (2H, br, s, OH-Ph); 4.7 ppm (br, s, 2H, benzylic).

Anal. for $C_{26}H_{24}N_2O_2$ Calcd. C, 78.76; H, 6.10; N, 7.07
Found C, 78.69; H, 6.07; N, 7.02.

1,2-Dipropyl-1,2-diaminophenylethane(XIII)

Treatment of crotonalaniline (d, 1.021, 14.3 ml), zinc dust (1.0 g) and ethanol chloroform mixture (20:1; 182 ml) under reflux on a steam bath for 4.5 hr. The reaction mixture after usual work-up and removal of solvent gave an oily residue which was crystallised from ethanol-Ether mixture (2:1). Yield, 11.3 g (85%); m.p. 168-70°.

UV : λ max (MeOH) 252 nm

IR : ν max (KBr) 3310-3280 (NH); 3010, 1585 (C=C—H, C=C) 2870 (H-C-H); 760 cm^{-1}

NMR : δ ($CDCl_3$) 7.1-7.5 (m, 10H, aromatic); 5.8 (m, CH_3-CH-CH); 6.4 (m, 2H, -CH=CH-); 1.75 ppm (d, 6H, CH_3-CH=C-)

Anal. for $C_{20}H_{24}N_2$ Calcd. C, 82.14; H, 8.27; N, 9.58
Found C, 82.07; H, 8.22; N, 9.53%

1,2-Dipropane-1,2-diaminophenylethane(LIV)

A mixture of butyralaniline (15 ml, d, 0.98) ethanol-chloroform mixture (82 ml; 20:1) and zinc dust (2.5 g) was gently heated under reflux on a steam bath for 5 hr. The reaction mixture was then filtered to remove zinc slurry. This was concentrated in vacuo to yield the compound (LIV). This was recrystallized from ethanol-ethylacetate mixture (1:0.5). Yield, 13.8 g (92 %); m.p. 142°.

UV : λ max (EtOH) 235 nm

IR : ν max (Nujol) 3210-3150 (NH), 3025, 1575 (C=C—H, C=C)

NMR : δ (CCl_4) 6.9-7.2 (m, 10H, aromatic protons); 3.20 (2H, t, $CH_3(CH_2)_2CH$-NH); 1.4 (m, 4H, $CH_3CH_2CH_2$x2); 1.02 ppm (t, 6H, $-CH_3$).

Anal. for $C_{20}H_{28}N_2$ Calcd. C, 81.03; H, 9.52; N, 9.45
Found C, 80.93; H, 9.47; N, 9.39%

1,2-Dimethyl-1,2-diaminophenylethane(LV)

Acetalaniline (d, 0.92; 13 ml) was mixed with ethanolic chloroform (100 ml; 20:1) and zinc dust (2.0 g). This was heated at reflux temperature for 6 hr. Removal of solvent afforded an oil. Crystallization of this oil from ethanol gave (LV). Yield, 10.53 g (81 %); m.p. 174°.

UV : λ max (EtOH) 220 nm

IR : ν max (Nujol) 3310-3300(NH); 3010, 2960 (C=C—H, C-H stretchings) 1600, 1560 (C=C); 780, 750 cm^{-1} (mono substituted benzene).

NMR : δ(CCl_4) 6.8-7.2 (m, 10H, aromatic protons); 3.2 (2H, q, H_3C-CH_2-); 1.15 ppm (t, 6H, $-CH_3$).

Anal. for $C_{16}H_{20}N_2$ Calcd. C, 79.95; H, 8.35; N, 11.66

Found C, 79.83; H, 8.32; N, 11.59%

1,2-Dicinnamal-1,2-diaminophenylethane(XVI)

A mixture of cinnamalaniline (2.07 g), zinc dust (2.0 g) and ethanolic-chloroform (20:1; 82 ml) was gently heated under reflux on a steam bath for 5 hr and filtered hot. The filtrate was concentrated to a small volume and cooled. Crystalline product (XVI) thus obtained was filtered and air dried. Yield, 1.82 g (88%); m.p. 155°.

UV : λ max (MeOH) 285 nm

IR : ν max (KBr) 3150-3120 (NH); 3030 (C=C—H); 1620 (-C=C-); 1590, 1540 (C=C); 760 cm^{-1} (mono-substituted benzene)

NMR : δ($CHCl_3$) 6.8-7.2 (m, 20H, aromatic protons); 6.2 (t, vinylic protons); 4.9 ppm (dist. d, 2H, allylic protons).

Anal. for $C_{30}H_{28}N_2$ Calcd. C, 86.50; H, 6.78; N, 6.73

Found C, 86.42; H, 6.71; N, 6.69%

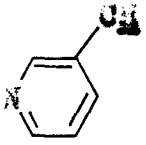
1,2-Dipyridyl-1,2-diaminophenylethane(XVII)

Pyridyl-4-aniline (3.64 g) was dissolved in ethanol-chloroform mixture (20:1; 100 ml). To this zinc dust (1.5 g) was added and the reaction mixture was gently heated for 5 hr. After the reduction was complete, the reaction mixture was worked-up according to the usual procedure. The crystalline product thus obtained was recrystallised from ethanol. Yield, 3.40 g (93.5 %); m.p. 145°.

UV : λ max (MeOH) 258 nm

IR : ν max (KBr) 3220 (NH) 3005 (C=C—H, benzene ring); 1580, 1420 cm^{-1} (C=C, C-N).

NMR : δ ($DMSO-d_6$) 8.90 (m, 4H,  x 2); 7.1-7.5 (m, 14H, 10 aromatic and 4 pyridyl protons); 5.8 ppm (d, 2H,



x 2)

Anal. for $C_{24}H_{22}N_4$ Calcd. C, 78.66; H, 6.05; N, 15.29
Found C, 78.57; H, 6.03; N, 15.25%

1,2-Difurfural-1,2-diaminophenylethane(XVIII)

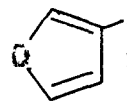
A mixture of furfuralaniline (3.42 g), zinc dust (1.5 g) and ethanolic chloroform (82 ml; 20:1) was gently heated on a water bath for 6 hr and filtered. The filtrate was evaporated under diminished pressure to 8 ml volume and cooled. Crystalline product so secured was recrystallised from Ethanol.

Yield, 2.85 g (83.5%); m.p. 182°

UV : λ max (EtOH) 255 nm

IR : ν max (KBr) 3210-3025 (NH, C=C—H) and 1630 

1595, 1550 (C=C); 730 cm^{-1} (monosubstituted benzene)

NMR : δ (DMSOd_6) 6.5-7.3 (m, 10H, aromatic protons) 7.52 (dist. d,  x 2); 6.2 (t, 2H,  x 2); 4.2 ppm (d, 2H, )

Anal. for $C_{22}H_{20}N_2O_2$ Calcd. C, 76.72; H, 5.85; N, 8.13

Found C, 76.68; H, 5.79; N, 8.09%

<u>1,2-Diphenyldiethyl-1,2-diaminophenylethane(XIX)</u>

1-Ethyl-1-benzalaniline (d, 1.04; 19 ml) was diluted with chloroform-ethanol mixture (100 ml; 20:1), to this zinc dust (3.0 g) was added and the reaction mixture was refluxed on a boiling water bath for 4.5 hr. It was then filtered to remove zinc slurry and the zinc slurry was washed with hot ethanol. The usual work-up of the combined filtrate and washing under vacuo afforded a compound (XIX). Yield, 17.76 g (93.5%); m.p. 184°

UV : λ max (EtOH) 235 nm

IR : ν max (KBr) 3200 (NH); 3030 (C=C—H); 1600, 1575 cm^{-1} (C=C); 780, 745 cm^{-1} (mono-substituted benzene).

NMR : δ (DMSOd_6) 3.9 (br. s, 2H, amino protons); 6.9-7.3 (m, 20H, aromatic protons); 1.8 (q, 4H, CH_2-CH_3); 1.3 ppm (t, 6H, -CH_2-CH_3).

Anal. for $C_{30}H_{32}N_2$ Calcd. C, 85.67; H, 7.67; N, 6.66

Found C, 85.58; H, 7.61; N, 6.61%

1,2-Diphenyldimethyl-1,2-diaminophenylethane(XX)

1-Methyl-1-benzalaniline (d, 1.12, 18.5 ml) was dissolved in ethanolic chloroform (120 ml; 20:1) and zinc dust (3.5 g) was added. The contents were refluxed on a steam bath for 5 hr and filtered hot. The filtrate was concentrated under suction to 5 ml and diluted with hot ethanol (10ml). This was cooled to yield crystalline product, and recrystallized from methanol. Yield, 17.4 g (94%); m.p. 167°.

UV : λ max (MeOH) 295 nm

IR : ν max (KBr) 3310 (NH); 3015 (Ar C—H) 2980 (C-H, stretching) 1590 cm^{-1} (C=C).

NMR : δ ($CDCl_3$) 8.5 (s, 2H, NH, D_2O exchangeable) 6.5-7.55 (m, 20H, aromatic protons) 1.52 ppm (s, 6H, CH_3-$C_{1,2}$)

Anal. for $C_{28}H_{28}N_2$ Calcd. C, 85.67; H, 7.19; N, 7.14

Found C, 85.58; H, 7.12; N, 7.09%

1,2-Dicyclohexane-1,2-diaminophenylethane(XXI)

Treatment of zinc dust (2.5 g) with cyclohexalaniline (d, 1.5; 11.6 ml) in ethanolic chloroform (122 ml; 20:1) was

carried out by refluxing the reaction mixture on a steam bath for 5.5 hr. On completion of reduction it was filtered to remove zinc slurry. The usual work-up of the reaction mixture followed by crystallization provided (LXI). Yield, 10.67 g (92%); m.p. 180°.

UV : λ max (MeOH) 245 nm

IR : ν max (KBr) 3120 (NH); 3020 (C=C—H); 2980, 1610, 1545 (C=C, C=N); 1370 cm^{-1} (C-H).

NMR : δ ($CDCl_3$) 3.45 (d, 2H, NH-Ph, D_2O exchangeable); 7.3-7.5 (10H, m, aromatic) 0.8-1.2 ppm (m, 20H, 2 x ⬡)

Anal. for $C_{24}H_{34}N_2$ Calcd. C, 82.23; H, 9.78; N, 7.99

Found C, 82.15; H, 9.69; N, 7.95%

1,2-Dimethyldiethyl-1,2-diaminophenylethane(LXII)

Isobutalaniline (d, 0.85; 17.3 ml), zinc dust (1.5 g) were taken in ethanol-chloroform mixture (20:1; 120 ml), and was heated for 5.5 hr on a steam bath and filtered. The filtrate was concentrated to 10 ml volume. Recrystallization from ethanol-benzene mixture (2:1) gave (LXII). Yield, 14.67 g (86%); m.p. 160°.

UV : λ max (MeOH) 265 nm

IR : ν max (KBr) 3220-3185 (NH); 3020 (benzene ring); 2980 (C—H), 1500, 1420 cm^{-1} (C=C, C-N).

NMR : δ ($CDCl_3$) 6.9-7.7 (m, 10H, aromatic protons); 1.7 (q, 4H, CH_3-CH_2); 1.5 (s, 6H, CH_3-C) 1.2 ppm (t, 6H, CH_3-CH_2-C$_{1,2}$)

Anal. for $C_{20}H_{28}N_2$ Calcd. C, 81.03; H, 9.52; N, 9.45
Found C, 80.95; H, 9.45; N, 9.41%

1,2-Dimethyl-1,2-diaminophenylethane(XIII)

A mixture of isopropalaniline (d, 0.95; 14 ml) zinc dust (2.5 g) and ethanolic chloroform (20:1; 122 ml) was gently heated under reflux for 6 hr. The contents were filtered hot and the zinc slurry was washed with hot ethanol (2 x 10 ml). The filtrate and washings were concentrated under vacuo to 10 ml volume and cooled. Crystalline product so secured was recrystallized from ether-ethanol mixture (2:1). Yield, 11.97 g (85.5%); m.p. 175°.

UV : λ max (EtOH) 230 nm

IR : ν max (KBr) 3220 (NH); 3025 (C=C—H); 2960 (C—H); 1585, 1550, 1490 cm^{-1} (C=C, C-N).

NMR : δ (DMSOd_6) 8.5 (br. s, 2H, NH-Ph, D_2O exchangeable); 6.8-7.25 (10H, m, aromatic); 1.8-1.5 ppm (d, 12H, 2 x CH_3-$C_{1,2}$).

Anal. for $C_{18}H_{24}N_2$ Calcd. C, 80.55; H, 9.01; N, 10.44
Found C, 80.48; H, 8.96; N, 10.41%

1,2-Dimethyl-(1,2-dicarboxyethane)-1,2-diaminophenyl ethane(XIV)

A mixture of 1-Methyl-3-carboxylicpropalaniline (2.38 g) ethanolic-chloroform (20:1; 82 ml) and zinc dust (1.5 g) was

heated gently under reflux on a steam bath for 5 hr. This was filtered and the filtrate was concentrated to a small volume (10 ml) and cooled. Crystalline material so secured and filtered, and recrystallized from emthanol. Yield, 2.11 g (39%); m.p. 135°

UV : λ max (EtOH) 325 nm

IR : ν max (Kbr) 3250 (NH); 3015 (C=C—H); 2980 (C—H stre-
ching); 2680-2560 (COOH); 1720 (COOH).

NMR : δ ($DMSOd_6$) 11.5 (br. S, 2H, COOH-$C_{1,2}$ diminished on D_2O shake); 7.52 (10H, m, aromatic protons); 2.0-2.8 (m, 8H, CH_2); 1.15 ppm (6H, S, CH_3-$C_{1,2}$).

Anal. for $C_{22}H_{28}N_2O_4$ Calcd. C, 68.72; H, 7.34; N, 7.29
Found C, 68.63; H, 7.29; N, 7.24%

1,2-Dicarboxyethane-(1,2-dicarboxy)-1,2-diaminophenyle ethane(LXV)

Powdered 1,3-Dicarboxylicpropalaniline (2.5 g), dissolved in chloroform-ethanol mixture (1:20; 182 ml), to this zinc dust (3.5 g) was added and the reaction mixture was then heated under reflux for 5.5 hr. The contents were filtered, Zinc slurry was washed with hot ethanol (2x15 ml). The combined filtrate and washings were concentrated to yield (LXV). This was recrystallized from methanol-benzene mixture to afford shining needle shape crystals. Yield, 2.05g (82%); m.p. 183°

UV : λ max (MeOH) 335 nm

IR : ν max (KBr) 3220-3180 (NH) 3010 (C=C—H); 2700-2635 (COOH) 1605, 1595, 1715 (COOH); 1350 cm^{-1} (C-N).

NMR : δ (DMSOd_6) 10.85 (br. S, 2d, 2xCOOH-$C_{1,2}$); 6.9-7.5 (m, 10H, aromatic protons); 1.85 ppm (m, 8H, $-CH_2$x4)

Anal. for $C_{22}H_{24}N_2O_4$ Calcd. C, 59.45; H, 5.44; N, 6.30

Found C, 59.38; H, 5.38; N, 6.25%

1,2-Tetracarboxy-1,2-diaminophenylethane(LXVI)

A mixture of powdered 1,1-Dicarboxylicmethalaniline(3.86 g) zinc dust (2.0 g) and ethanolic chloroform (20:1; 100 ml) was refluxed on a steam bath for 6 hr. After usual work-up of the filtrate and crystallisation, the compound (LXVI) was obtained. Yield, 3.33 g (86.5%); m.p. 178°.

UV : λ max (MeOH) 288 nm

IR : ν max (KBr) 3180-3015 (NH, C=C—H); 2855-2635 (COOH). 1725 (CO_2H); 1580, 1560, 1430 cm^{-1} (C=C, C-N).

NMR : δ (DMSOd_6) 11.7, 10.95 (br. S, 4H, COOH-$C_{1,2}$); 7.55 (m, 10H, aromatic protons); 6.55 ppm (2H, br. S, amino protons, diminished on D_2O shake).

Anal. for $C_{18}H_{16}N_2O_8$ Calcd. C, 55.67; H, 4.15; N, 7.21

Found C, 55.59; H, 4.08; N, 7.15%

1,2-Diphenyl-1,2-dihydrazonophenylethane(LXVII)

Benzaldehyde phenylhydrazone (3.92 g) was dissolved in ethyl alcohol-chloroform mixture (20:1; 122 ml). To this,

zinc dust (2.5 g) was added. The reaction mixture was gently heated under reflux on a steam bath for 5 hr. After the reaction was complete, this was filtered and the zinc slurry washed with hot ethanol (2x10 ml). The combined filtrate and washings were concentrated under vacuo. On cooling the crystalline product obtained, was recrystallized from hot ethanol. Yield, 3.72 g (95%); m.p. 140°.

UV : λ max (ethanol) 345 nm

IR : ν max (KBr) 3240-3143 (NH); 3010, 1600 (C=C—H, C=C); 1450 (C-N); 740 cm^{-1} (monosubstituted benzene)

NMR : δ ($DMSOd_6$) 6.8-7.3 (m, 20H, aromatic protons); 5.8 (2H, dist. d, anilino protons, diminished on D_2O shake); 4.9 (br. s, 2H, benzylic); 3.8 ppm (2H, benzylamino protons).

Anal. for $C_{26}H_{26}N_4$ Calcd. C, 74.96; H, 7.55; N, 17.49

Found C, 74.82; H, 7.47; N, 17.44%

1,2-Di-(4-nitrophenyl)-1,2-dihydrazophenylethane(LXVIII)

p-Nitrobenzaldehyde phenylhydrazone(LXVI) (2.41 g) was subjected to reduction with zinc dust (2.5 g) in ethanolic chloroform (100 ml; 20:1) for 4.5 hr on a boiling water bath. The contents were filtered and zinc slurry washed with boiling ethanol-acetone mixture (1:2; 2x20 ml). The filtrate was reduced under vacuo to 12 ml volume, which on cooling provided a crystalline product, recrystallized from ethanol. Yield, 2.03 g (85%); m.p. 130°.

UV : λ max (MeOH) 285 nm

IR : ν max (KBr) 3255-3180 (NH); 3025 (C=C—H); 1600, 1580 155, 1330 (C=C, C-N) 780, 720 cm^{-1} (mono and di-substituted benzene).

NMR : δ ($DCCl_3$) 7.2-7.5 (m, 18H, aromatic protons); 5.7 (d, 2H, NH-Ph); 4.9 (t, 2H, $O_2N-C_6H_4-CH-NH$); 5.2 ppm (2H, S, benzylic protons).

Anal. for $C_{26}H_{24}N_6O_4$ Calcd. C, 64.45; H, 4.99; N, 17.35
Found C, 64.32; H, 4.92; N, 17.29

1,2-Di-(p-dimethylaminophenyl)-1,2-dihydrazophenylethane(LXIX)

4-Dimethylaminobenzaldehyde phenylhydrazone (2.25 g) was subjected to chemical reduction with zinc dust (2.0 g) in chloroform-ethanol mixture (1:20; 100 ml) on a steam bath. The reduction took 5.5 hr to complete. The reaction mixture was filtered hot to remove zinc slurry. The usual work-up afforded the product (LXIX). Yield, 1.86 g (98%); m.p. 118°.

UV : λ max (EtOH) 320 nm

IR : ν max (KBr) 3245-3185 (NH); 3015 (C=C—H, benzene ring); 2850 (w); 1600, 1580, 1420, 1360 cm^{-1}

NMR : δ ($DMSOd_6$) 6.5-7.2 (m, 20H, aromatic); 5.6 (s, 2H, benzylic); 4.1 ppm (12H, s, $-N(Me)_2$).

Anal. for $C_{30}H_{36}N_6$ Calcd. C, 74.96; H, 7.55; N, 17.49
Found C, 74.88; H, 7.47; N, 17.42

1,2-Bi-(2-hydroxyphenyl)-1,2-dihydrazonphenylethane(XXX)

A mixture of powdered 2-hydroxybenzaldehyde phenylhydrazone (2.12 g), ethanolic chloroform (100 ml, 20:1) and zinc dust (2.5 g) was refluxed on a steam bath. After 4 hr the reduction was complete. The reaction mixture was filtered and the residue washed with boiling ethanol (95 %, 15 ml). The excess solvent was evaporated under reduced pressure and cooled. Crude product so obtained was recrystallized from absolute ethanol. Yield, 2.07 g (78 %); m.p. 125°.

UV : λ max (MeOH) 230 nm

IR : ν max (Nujol) 3555 (OH); 3230-3185 (NH); 3020 (C=C—H); 1640, 1575, 1555, 1455, 1245, 730, 720 cm^{-1}

NMR : δ ($CDCl_3$) 8.85 (br. S, 2H, OH-C_6H_4-); 6.5-7.3 (m, 19H, aromatic protons); 4.50 (S, 2H, benzylic protons).

Anal. for $C_{26}H_{26}N_4O_2$ Calcd. C, 73.21; H, 6.41; N, 13.14
Found C, 73.15; H, 6.08; N, 13.09 %

1,2-Bi-(4-hydroxyphenyl)-1,2-dihydrazonphenylethane(XXXI)

The reaction of p-hydroxybenzaldehyde phenylhydrazone (2.12 g) in alcoholic chloroform (100 ml, 20:1) with zinc dust (2.5 g) was carried out at steam bath for 5.5 hr under reflux. After the reduction was complete, it was filtered. The usual work-up of the reaction mixture and subsequent

crystallisation gave bimolecular product (XXXI). Yield, 1.63 g (77%); m.p. 188°.

UV : λ max (EtOH) 285 nm

IR : ν max (KBr) 3545 (OH); 3220, 3170 (NH); 3020 (C=C—H); 1620, 1580, 1460, 1390, 785, 720 cm^{-1} (C=C, C-N, and di-substituted benzene).

NMR : δ ($CDCl_3$) 8.5 (2H, br, s, OH-Ph); 6.8-7.7 (m, 18H, aromatic); 4.4 ppm (s, 2H, benzylic protons)

Anal. for $C_{26}H_{26}N_4O_2$ Calcd. C, 73.85; H, 6.22; N, 13.20 Found C, 73.79; H, 6.17; N, 13.14%

1,2-Bis-(3,4-dimethoxyphenyl)-1,2-dihydrazonophenylethane(XXXII)

A mixture of 3,4-dimethoxybenzaldehyde phenylhydrazone (2.56 g) in ethanolic chloroform (100 ml; 20:1) and zinc dust (3.0 g) are refluxed for 5 hr on a water bath. Bimolecular reduction product thus obtained was chromatographed on glass plates, to check purity of the compound. Usual work-up and removal of solvent followed by crystallization from ethanol benzene mixture (1:0.5) gave pure product (XXXII). Yield, 2.05 g (80%); m.p. 105°.

UV : λ max (MeOH) 295 nm

IR : ν (Nujol) 3210-3145 (NH); 3030 (C=C H); 1620, 1575, 1390, 1020, 740 cm^{-1} (C=C, C-O).

NMR : δ ($DMSO-d_6$) 6.8-7.22 (16H, m, aromatic protons); 4.85 (s, 2H, benzylic protons); 3.2 ppm (s, 12H, H_3CO-Ph,

Anal. for $C_{30}H_{34}N_4$ Calcd. C, 70.02; H, 6.66; N, 10.89
Found C, 69.93; H, 6.61; N, 10.83%

1,2-Di-(2-nitrophenyl)-1,2-dihydrazonophenylethane(LXXIII)

Powdered phenylhydrazone of 2-nitrobenzaldhyde (2.41 g) was dissolved in ethanol chloroform mixture (20:1; 100 ml). To this zinc dust (2.5 g) was added and the reaction mixture heated on a steam bath for 6 hr. Usual work-up of the filtrate gave (LXXIII) as an oily residue, which was crystallized from aqueous ethanol (80%). Yield, 1.76 g (73%); m.p. 143°.

UV : λ max (EtOH) 325 nm

IR : ν max (KBr) 3245-3180 (NH); 3015 (C-H); 2080, 1640, 1635, 1575, 1360, 1320, 735 cm^{-1} (-N-N-, C-H, C-N).

NMR : δ ($CDCl_3$) 5.5 (2H, NH-Ph); 7.2-7.6 (m, 18H, aromatic protons); 6.3 (d, 2H, NH-CH-Ph-O_2N); 5.15 ppm (t, 2H, benzylic protons).

Anal. for $C_{26}H_{26}N_6O_4$ Calcd. C, 64.45; H, 4.99; N, 17.35
Found C, 64.39; H, 4.96; N, 17.31%

1,2-Di-(4-hydroxy-3-methoxyphenyl)-1,2-dihydrazonophenylethane(LXXIV)

A mixture of vanilline phenylhydrazone (2.12 g), zinc dust (2.5 g) and ethanolic chloroform (100 ml, 20:1) was refluxed for 6 hr. After usual work-up of the reaction

mixture and repeated crystallization from absolute alcohol furnished (LXXIV). Yield, 1.65 g (78%); m.p. 173°.

UV : λ max (MeOH) 332 nm

IR : ν max (KBr) 3665 (OH); 3210-3160 (NH); 3030 (C=C—H); 2040 (w) (N=N); 1490, 1320, 1575, 820 cm^{-1} (C-N, C=C).

NMR : δ (DMSOd_6) 7.2 (m, 10H, aromatic protons) 6.5 (m, 6H, trisubstituted benzene); 9.8 ppm (dist. d, 2H, OH-Ph) 3.5 (6H, s, 2xOMe-Ph); 4.2 (br. s, 2H, benzylic protons).

Anal. for $C_{28}H_{30}N_4O_4$ Calcd. C, 69.12; H, 6.22; N, 11.51

Found C, 69.05; H, 6.18; N, 11.46%

1,2-Dicinnamal-1,2-dihydrazophenylethane(LXXV)

A mixture of cinnamaldehyde phenylhydrazone (2.22 g), zinc dust (2.5 g) and ethanol-chloroform mixture (20:1; 100 ml) was gently refluxed on a steam bath for 4.5 hr. The contents were then filtered hot and the zinc slurry washed with hot acetone-alcohol mixture (2:1, 2x15 ml). Combined filtrate and washings reduced under vacuo, which afforded the bimolecular reduction product (LXXV). It was recrystallized from ethanol. Yield, 1.88 g (85%); m.p. 155-6°.

UV : λ max (MeOH) 315 nm

IR : ν max (KBr) 3240-3150 (NH); 3010 (C=C—H); 2035(w) (N=N); 1655, 1645, 1600, 1575, 1420, 1390, 780 cm^{-1} (C=C, C-N) mono-substituted benzene).

NMR : δ ($CDCl_3$) 6.3-7.5 (m, 20H, aromatic protons); 3.82 (d, 2H, allylic protons); 5.9 ppm (t, 2H, J=7Hz vinylic protons attached to allylic carbon) 6.1 (d, 2H, benzylidene protons).

Anal. for $C_{30}H_{30}N_4$ Calcd. C, 80.68; H, 6.77; N, 12.55
Found C, 80.62; H, 6.71; N, 12.52%

1,2-Bis-(p-methoxyphenyl)-1,2-dihydrazonophenylethane(LXXVI)

Treatment of p-anisaldehyde phenylhydrazone (3.92 g) with zinc dust (4.5 g) in chloroform-ethanol mixture (1:20; 152 ml) on a steam bath for 4.5 hr. On subsequent work-up and removal of the solvent yielded bimolecular reduction product (LXXVI) as an oil. This was recrystallised from ethanol-benzene mixture (1:0.5). Yield, 2.82 g (72%); m.p. 115°.

UV : λ max (EtOH) 380 nm

IR : ν max (Nujol) 3275, 3130 (NH); 3030 (C=C—H, aromatic); 1585, 1600, 1440, 1355, 1260 cm^{-1}

NMR : δ (CCl_4+ $DMSO-d_6$) 6.5-7.32 (m, 18H, aromatic protons); 3.9 (6H, s, H_3CO-Ph-$C_{1,2}$); 4.18 ppm (broad, s, 2H, benzylic protons).

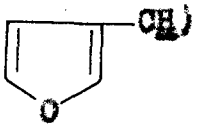
Anal. for $C_{28}H_{30}N_4O_2$ Calcd. C, 73.98; H, 6.65; N, 12.33
Found C, 73.92; H, 6.60; N, 12.28%

1,2-Difurfural-1,2-dihydrazophenylethane(LXXVII)

A mixture of furfuraldehyde phenylhydrazone (3.72 g), ethanolic chloroform 150 ml, 20:1) and zinc dust (5.0 g) was gently heated for 5 hr on a steam bath. Usual work-up of the reaction mixture and subsequent crystallization from ethanol gave a product (LXXVII) as fine crystals. Yield, 2.34 g (63%); m.p. 169-70°.

UV : λ max (EtOH) 325 nm

IR : ν max (KBr) 3220-3180, 3025 (NH, C=C—H); 1590, 1640, 1435, 1320, 1280 cm^{-1} (C=C, C——J and C-N functions).

NMR : δ ($CDCl_3$) 6.8-7.45 (m, 10H, aromatic protons) 4.38 (broad, s, 2H, 2 x )

Anal. for $C_{22}H_{22}N_4O_2$ Calcd. C, 70.57; H, 5.92; N, 14.96
Found C, 70.48; H, 5.89; N, 14.91%

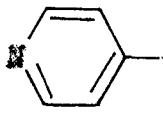
1,2-Di-4-pyridyl-1,2-dihydrazophenylethane(LXXVIII)

Pyridyl-4-aldehyde phenylhydrazone (3.95 g) treated with zinc dust (5.0 g) in chloroform-ethanol mixture (1:20; 150 ml), was gently heated under reflux. After 5.5 hr it was filtered to remove zinc slurry. The filtrate was concentrated under reduced pressure. Recrystallization from ethanol furnished (LXXVIII) as needle shaped crystals. Yield, 2.68 g (68%); m.p. 184-5°.

UV : λ max (ethanol) 275 nm

IR : ν max (KBr) 3280, 3220, 3010 (NH, C=C—H) 1635, 1575, 1610, 1440, 1325 cm^{-1} (C-C, C=C, C-N streching frequencies).

NMR : δ ($CDCl_3$) 7.1-7.55 (10H, m, aromatic protons 2xPh-NH);

4.75 (d, 2H, );

Anal. for $C_{24}H_{24}N_6$ Calcd. C, 72.70; H, 6.10; N, 21.20
Found C, 72.63; H, 6.07; N, 21.17%

1,2-Dicarboxyethane-1,2-dihydrazophenylethane(LXXIX)

A mixture of ketomalonic acid phenylhydrazone (2x22g) (2.22 g), zinc dust (2.5 g) and ethanolic chloroform (82 ml; 20:1) was heated on a boiling water bath for 6 hr. The filtrate was worked up in the usual manner to afford the dimerised product (LXXIX). Yield, 1.45 g (65%); m.p. 186-87°.

UV : λ max (MeOH) 332 nm

IR : ν max (KBr) 3220, 3145, 3015 (NH, Ar C—H) 2620, 2500 (COOH) 2920, 1730, 1650, 1380 cm^{-1} (COOH, C H, C C and C-N streching frequencies).

NMR : δ ($DMSOd_6$) 11.5 (2H, br. S, $-CH_2-CO_2H$) 10.5 (2H, br. S, $HO_2C-C_{1,2}$); 6.9-7.4 (m, 10H, aromatic); 2.8 ppm (4H, S, CH_2-CO_2H)

Anal. for $C_{20}H_{22}N_4O_8$ Calcd. C, 53.81; H, 4.97; N, 12.55
Found C, 53.73; H, 4.82; N, 12.51%

1,2-(Di-Carboxy)-1,2-dicarboxyethane-1,2-dihydrazonophenylethane(LXXX)

2-Oxoglutaric acid phenylhydrazone (2.36 g) was dissolved in ethanolic chloroform (100 ml; 20:1). To this zinc dust (3.0 g) was added and the reaction mixture was heated on a steam bath for 5.5 hr. The similar work-up of the reaction mixture provided an oily residue, which was crystallised out on cooling in a freezer. Yield, 1.44 g (61%); m.p. 180°.

UV : λ max (MeOH) 335 nm

IR : ν max (KBr) 3220, 3165 (NH); 3020 (C=C—H, benzene ring); 2585-2565 (COOH); 1620, 1575, 1730, (C=O, COOH); 1445, 1380 cm^{-1} (C-N).

NMR : δ ($DMSOd_6$) 10.8 (br. s, 2H, $-CH_2-COOH$); 9.5 (br. s, 2H, $COOH-C_{1,2}$, disappeared on D_2O shake); 7.1-7.5 (m, aromatic protons) 2.9 and 1.8 ppm (r, 4H, 2 x CH_2COOH).

Anal. for $C_{22}H_{26}N_4O_8$ Calcd. C, 55.69; H, 5.52; N, 11.81
Found C, 55.61; H, 5.48; N, 11.77%

1,2-Dimethyl(1,2-dicarboxyethane)-1,2-dihydrazonophenylethane(LXXXI)

To a powdered phenylhydrazone of Levulinic acid (2.03 g) was added ethanolic chloroform (100 ml; 2:1), zinc

dust (3.0 g) and the reaction mixture was gently refluxed for 5 hr on a steam bath. The contents were then filtered and the filtrate was evaporated under vacuo, when an oily substance was obtained. Crystallisation of this oil from methanol provided (LXXXII). Yield, 1.4 g (67%); m.p. 152°.

UV : λ max (EtOH) 320 nm

IR : ν max (KBr) 3225-3185 (NH); 3015 (benzene ring stretching) 2950, 2620, 2595, 1720, 1645, 1575, 1445, 1360 cm^{-1}

NMR : δ ($DMSOd_6$) 7.2-7.35 (m, 10H, aromatic) 9.85 (broad, S, 2H, $-CH_2-CO_2H$, D_2O exchangeable); 2.9 (t, 4H, CH_2CO_2H) 1.15 (S, 6H, $CH_3-C_{1,2}$); 1.3 and 1.52 ppm (t, 4H, 2 x $(CH_2)_2COOH$).

Anal. for $C_{22}H_{30}N_4O_4$ Calcd. C, 63.75; H, 7.30; N, 13.52

Found C, 63.68; H, 7.26; N, 12.47%

1,2-Dicarboxy-1,2-dihydrazophenylethane(LXXXII)

The reduction of glyoxalic acid phenylhydrazone (3.28 g) with zinc dust (4.0 g) in chloroform-ethanol mixture (1:20; 100 ml) was effected by heating the reaction mixture on a steam bath for 5.5 hr. It was then filtered to remove zinc slurry. The usual work-up of the filtrate followed by crystallisation afforded a product (LXXXII). Yield, 2.13 g (65%); m.p. 210°.

UV : λ max (EtOH) 245 nm

IR : ν max (KBr) 3245-3195 (NH) 2810, 2690 (w); 1735, 1575, 1340, 1295 cm^{-1} (C=O, C-N, C-O, COOH).

NMR : δ ($DMSOd_6$) 11.55 (br. S, 2H, $CO_2\underline{H}$-$C_{1,2}$, D_2O Exchangeable) 7.1-7.3 (10H, m, aromatic protons) 3.6 ppm (d, 2H, HO_2C-$\underline{CH}$-NH).

Anal. for $C_{16}H_{18}N_4O_4$ Calcd. C, 58.17; H, 5.49; N, 16.96
Found C, 58.12; H, 5.43; N, 16.92%

1,2-Dicarboxyphenyl-1,2-dihydrazophenylethane(LXXXIII)

To powdered phenylhydrazone of phthalaldehydic acid (2.5 g), dissolved in ethanol-chloroform mixture (20:1, 82 ml) was added zinc dust (2.5 g) and this was refluxed on a boiling water bath for 6 hr. The reaction mixture was filtered hot and on removal of solvent under diminished pressure gave on oil, which was crystallized from methanol. Yield, 1.48 g (62%); m.p. 205°.

UV : λ max (EtOH) 255 nm

IR : ν max (Nujol) 3210-3185 (NH) 3015 (C=O—H); 2635-2590 (C-H, $CO\underline{O}H$); 1730, 1610, 1585, 1440, 1390 cm^{-1} ($\underline{C}OOH$, C C, C-N).

NMR : δ ($DMSOd_6$-CCl_4) 9.58 (br. S, 2H, Ph-COOH-$C_{1,2}$); 7.15-7.55 (m, 18H, aromatic protons); 4.9 (S, 2H, benzylic

Anal. for $C_{28}H_{26}N_4O_4$ Calcd. C, 69.69; H, 5.43; N, 11.61
Found C, 69.58; H, 5.38; N, 11.56%

1,2-Dimethyl-1,2-dihydrazophenylethane(LXXXIV)

A mixture of acetone phenylhydrazone (2.96 g), zinc dust (3.0 g) and ethanolic chloroform (82 ml; 20:1) was

gently refluxed on a steam bath for 6 hr. On completion of reduction, the reaction mixture was filtered hot to remove zinc slurry. Work-up of the filtrate in the usual manner and removal of solvent gave (LXXIV). This was recrystallised from ethanol. Yield: 2.05 g (69%); m.p. 118°.

UV : λ max (EtOH) 225 nm

IR : ν max (KBr) 3310-3240 (NH); 3030, 2710, 1440, 1325, 785 cm^{-1} (C=O N, C-H, C-N, mono-substituted benzene)

NMR : δ (CCl_4) 7.2-7.8 (m, 10H, aromatic protons); 2.3 (S, 6H, CH_3-O-); 1.95 ppm (S, 6H, CH_3-C-)

Anal. for $C_{16}H_{22}N_4$ Calcd. C, 71.07; H, 8.20; N, 20.73
Found C, 71.01; H, 8.18; N, 20.69%

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Reduction of Schiff's Bases and Phenylhydrazones by Zinc Dust

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Schiff's bases[1] when subjected to the chemical action of zinc dust and chloroform in ethyl alcohol at steam bath temperature for varying times yield 1,2-diaminophenylethanes in crystalline form and in good yield (Table 1).

Formation of a covalent bond takes place to provide a C-C linkage. Thus a sigma bond is formed between two free radicals. This method may be an important method for the preparation of substituted amines.

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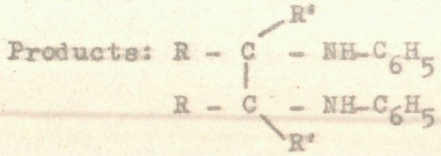
TABLE - 1

Reduction of Schiff's Bases

Products: 

S. No.	Anilino Schiff's bases of	Time of reflux (hrs)	R	R'	Products	M.P. °C	Yield %
1.	Benzaldehyde	4.5	C_6H_5-	H	$C_{26}H_{26}N_2$	130	93.5
2.	p-Dimethylamino-benzaldehyde	4	p-$(CH_3)_2$-N-C_6H_4-	H	$C_{30}H_{34}N_4$	195	95
3.	Anisaldehyde	5	o-CH_3-O-C_6H_4-	H	$C_{28}H_{28}N_2O_2$	190	93
4.	Veratraldehyde	5.5	3,4 $(CH_3O)_2$-C_6H_3	H	$C_{30}H_{32}N_2O_4$	195	91.5
5.	p-Nitrobenzaldehyde	5.5	p-NO_2-C_6H_4-	H	$C_{26}H_{22}N_4O_4$	160-61	84
6.	Salicylaldehyde	6	o-OH-C_6H_4-	H	$C_{26}H_{24}N_2O_4$	165	85
7.	2-Nitrobenzaldehyde	4.5	o-NO_2-C_6H_4-	H	$C_{30}H_{28}N_4O_4$	174	94
8.	2,4,dihydroxy-benzaldehyde	5	2,4$(OH)_2$-C_6H_3-	H	$C_{26}H_{24}N_2O_4$	160	88
9.	3,4,5 Trimethoxy-benzaldehyde	5	3,4,5$(OCH_3)_3$-C_6H_2-	H	$C_{32}H_{36}N_2O_6$	210	79
10.	p-Hydroxybenzaldehyde	5	p-OH-C_6H_4-	H	$C_{26}H_{24}N_2O_2$	194	86

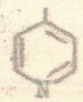
11. Crotonaldehyde	4.5	$CH_3CH=CH-$	H	$C_{20}H_{24}N_2$	168-70	85
12. n-Butyraldehyde	5	$CH_3-CH_2-CH_2-$	H	$C_{20}H_{28}N_2$	142	92
13. Acetaldehyde	6	CH_3-	CH_3	$C_{16}H_{20}N_2$	174	81
14. Cinnamaldehyde	5	$C_6H_5CH=CH-$	H	$C_{30}H_{28}N_2$	155	88
15. Pyridyl-4-aldehyde	4		H	$C_{26}H_{22}N_4$	145	93.5
16. Furfuraldehyde	6		H	$C_{24}H_{20}N_2O_2$	182	83.5
17. Propiophenone	4.5	C_2H_5-	C_6H_5	$C_{28}H_{32}N_2$	184	93.5
18. Acetophenone	5	C_6H_5-	CH_3	$C_{28}H_{28}N_2$	167	94
19. Cyclohexanone	5.5	$(CH_2)_5-$	C_6H_5	$C_{24}H_{34}N_2$	180	92
20. Ethyl Methyl Ketone	5.5	C_2H_5	CH_3	$C_{20}H_{28}N_2$	160	86
21. Acetone	6	CH_3	CH_3	$C_{18}H_{28}N_2$	175	85.5
22. Levulinic acid	5	CH_3	$(CH_2)_2CO_2H$	$C_{22}H_{26}N_2O_4$	135	89
23. 2-Oxoglutaric acid	5.5	$-(CH_2)_2CO_2H-$	CO_2H	$C_{20}H_{20}N_2O_8$	183	82
24. Ketomalonic acid	6	HO_2CCH_2-	CO_2H	$C_{18}H_{16}N_2O_8$	178	86.5

TABLE - 2

Reduction of Phenylhydrazones

Products: $R-\overset{R'}{\underset{R'}{C}}-NH-NH-C_6H_5$ and $R-\overset{}{\underset{R'}{\overset{R'}{C}}}-NH-NH-C_6H_5$

S. No.	Phenylhydrazones of	Times of reflux (hrs)	R	R'	Products	M.P. °C	Yield %
1.	Benzaldehyde	5	C_6H_5-	H	$C_{26}H_{26}N_4$	140	95
2.	p-Nitrobenzaldehyde	4.5	$p,NO_2-C_6H_4-$	H	$C_{26}H_{29}N_6O_4$	130	83
3.	p-Dimethylamino-benzaldehyde	5.5	$p,(CH_3)_2-N-C_6H_3$	H	$C_{30}H_{36}N_6$	118	98
4.	Salicylaldehyde	4	$o-OH-C_6H_4-$	H	$C_{26}H_{26}N_4$	125	78
5.	p-Hydroxybenzaldehyde	5.5	$p,HO-C_6H_4-$	H	$C_{26}H_{26}N_4$	188	77
6.	Veratraldehyde	5	$3,4(CH_3O)_2C_6H_3-$	H	$C_{30}H_{34}N_4O_4$	105	80

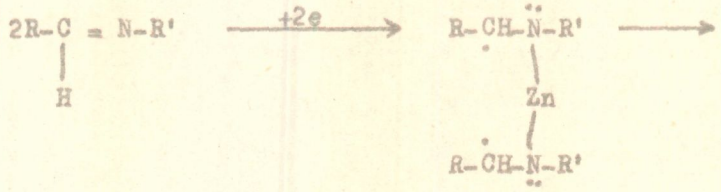
7. o-NO_2-benzaldehyde	6	o-NO_2-C_6H_4-		H	$C_{26}H_{24}N_4O_2$	143	73
8. Vanillins	6	4,HO,3-$CH_3OC_6H_3$-		H	$C_{28}H_{30}N_4O_4$	173	78
9. Cinnamaldehyde	4.5	$C_6H_5CH{=}CH$-		H	$C_{30}H_{34}N_4$	155-56	85
10. Anisaldehyde	4.5	p-CH_3O C_6H_4-		H	$C_{28}H_{36}N_4O_2$	115	72
11. Furfuraldehyde	5			H	$C_{24}H_{22}N_4O_2$	169-70	63
12. Pyridyl-4-aldehyde	5.5			H	$C_{26}H_{24}N_6$	184-85	68
13. Ketomalonic acid	6	-H_2CCO_2H		CO_2H	$C_{18}H_{18}N_4O_8$	186-87	65
14. 2-Oxoglutaric acid	5.5	-$(CH_2)_2CO_2H$		CO_2H	$C_{20}H_{22}N_4O_8$	180	61
15. Levulinic acid	5	-CH_3	$(CH_2)_2CO_2H$		$C_{22}H_{28}N_4O_4$	152	67
16. Glyoxylic acid	5.5	-CO_2H		H	$C_{16}H_{18}N_4O_4$	210	65
17. Phthalaldehydic acid	6	HO_2C C_6H_4-		H	$C_{28}H_{24}N_4O_4$	205	62
18. Acetone	6	-CH_3		CH_3	$C_{18}H_{25}N_4$	92-3	69

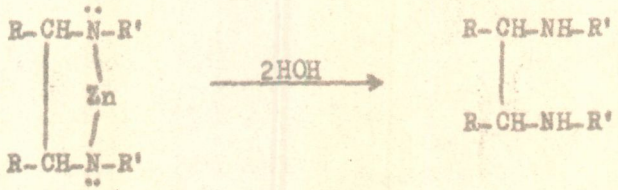
Phenylhydrazones of carbonyl compounds when subjected to catalytic reduction using Pd/C catalyst or zinc/calcium chloride in aqueous alcohol react with scission of N-N bond[2,3]. We have tried reduction of phenylhydrazones of aldehydes, ketones and keto acids in alcohol containing zinc dust and chloroform at reflux temperature. To our surprise bimolecular reduction products were obtained instead of amino compounds (Table 2).

Yields in certain cases are not encouraging compared to bimolecular reduction of Schiff's bases.

A somewhat similar mechanism as proposed for the formation of bimolecular reduction products of Schiff's bases may also be proposed for the bimolecular reduction of phenylhydrazones.

Mechanism





EXPERIMENTAL

Satisfactory analyses were obtained for all compounds reported in this work. Melting points were taken on a Kofler hot block and are uncorrected. IR spectra were measured on a Perkin-Elmer Infra-cord model DU620, UV spectra were measured with a Beckmann model DU. Molecular weight determination using Beckmann's depression in freezing point method are in good agreement with the respective calculated values.

Thin-layer chromatograms were run on glass plates precoated with Silica gel and sprayed with 20% perchloric acid. Solutions were dried over anhydrous sodium sulphate.

A. p-Dimethylaminobenzalaniline (5 g) in ethanol chloroform mixture (20:1) 100 ml was taken in a 250 ml round bottom flask, to which (1 g) zinc dust was added. The mixture was then refluxed on a water bath for 4 hr to observe the colour change of the reaction mixture from dark yellow to light yellow indicating the completion of reduction. Zinc dust slurry removed from the mixture through filtration was washed once with boiling ethanol. The filtrate and washings were combined and concentrated under reduced pressure to a volume of 25 ml, and kept at room temperature. The crystallised product thus obtained was filtered and recrystallized from ethanol. It melted at 195°C and weighed (4.76 g) 93% yield, UV $\lambda_{max}^{ethanol}$ 432 nm.

IR (Nujol) 3240, 1600, 1575, 1490, 1380 cm^{-1}

Anal: for $C_{30}H_{34}N_4$

Calcd: C, 79.96; H, 7.61; N, 12.43

Found: C, 79.93; H, 7.59; N, 12.42.

B. Benzaldehyde phenylhydrazone (5 g) was taken in a 250 ml round bottom flask. To this zinc dust (1 g) and 100 ml of chloroform in ethyl alcohol (1:20) was added. The mixture was refluxed on a water bath for 5 hr. The contents were then filtered on a Buchner funnel and the zinc slurry was washed with boiling ethanol (30 ml). The filtrate and washings were combined and concentrated under reduced pressure on a steam bath to 25 ml, which was then kept at room temperature overnight. The crystalline reduction product thus obtained was filtered and recrystallized from ethanol. It melted at 140°C and weighed 4.76 g (95%) yield.

UV $\lambda_{\text{EtOH}}^{\text{max}}$ 345 nm

IR (Nujol) 3148, 3220, 2350, 1600, 1450, 1315 cm^{-1}

Anal: for $C_{30}H_{36}N_6$

Calcd: C, 74.96; H, 7.55; N, 17.49.

Found: C, 74.92; H, 7.52; N, 17.44.

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